Vol. 15 MARCH, 1932 No. 3

Journal
of the
American Ceramic Society

Abstracts
Vol. 11, No. 3

Bulletin
Vol. 11, No. 3

A Monthly *Journal* Devoted to the Arts and Sciences
Related to the Silicate Industries

With profound appreciation of his leadership and his scientific contributions to ceramics, this issue is dedicated as a memorial to Edward Orton, Jr., Founder, First Secretary and Editor, Past-President, Trustee, Organizer and First Chairman of the Fellows.

Publication Office: 20th & Northampton Sts., Easton, Pa.

Editorial and Advertising Office: 2525 N. High St., Columbus, Ohio.

Executive Office: 2525 N. High St., Columbus, Ohio.

Committee on *Publications:* J. T. Littleton, Chairman; L. Navias, L. J. Trostel, A. E. R. Westman, Ross C. Purdy.

Entered as second class matter at the post office at Easton, Pa., under the Act of March 3, 1879.

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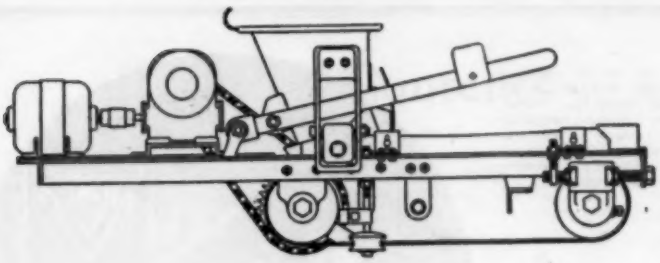

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RESIDUALS IN THE MELTING OF COMMERCIAL GLASSES*

By W. Eitel and W. Weyl

(Translated by S. R. Scholes)

ABSTRACT

By heating alkali silicates under CO_2 at high pressures, alkali carbonates are reformed to an extent depending upon temperature, pressure, and chemical affinity. The CO_2 thus existing homogeneously dissolved in the glass, and other anions and oxygen similarly dissolved and in chemical equilibrium are termed "melt-residuals" (Schmelzrelikte).

Their importance in planing, coloring, decolorizing, machine-working, vacuum bulb, and electric-lamp manufacture is discussed.

I. Introduction

In the melting of a glass a series of chemical reactions take place, which lead to the result that silica, stable at high temperatures, combines with alkalis and alkaline earths to form silicates and drives out the anions of the salts introduced in the batch. The reaction, for example, should be considered according to whether sodium metasilicate forms from sodium carbonate or sodium sulphate and silica:

$$Na_2CO_3 + SiO_2 = Na_2SiO_3 + CO_2$$
$$Na_2SO_4 + SiO_2 = Na_2SiO_3 + SO_3$$

On the basis of the Law of Mass Action the following may be stated: An equilibrium between the reacting components will be established, whose state depends upon the temperature and the concentration of the respective components. For a given temperature the relation holds as follows:

$$\frac{C_{Na_2CO_3} \times C_{SiO_2}}{C_{Na_2SiO_3} \times C_{CO_2}} = \text{a constant}$$

If the carbon dioxide generated is removed by pumping it away, or its partial pressure is reduced by introducing another gas, the equilibrium shifts to the right and fresh molecules of sodium carbonate come into reaction with silica. In commercial glasses, which, of course, contain a much higher concentration of silica than is necessary for the formation of sodium metasilicate, the decomposition of the sodium carbonate present goes so far that the influence of the partial pressure of carbon dioxide in the furnace atmosphere is neglected, and the three-component system, alkali–lime–silica, is regarded as the physical-chemical foundation of the resultant glass.

It will be shown that it is nevertheless worth while to pay some attention to the equilibria of the residuals found in the molten glass. The term,

* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Glass Division). Received December 9, 1931.

"residuals," as used in the present work does not refer to batch-stones or similar portions unmelted and not brought into reaction, but solely to components dispersed homogeneously in the glass and to be found in equilibrium with it.

Concerning glasses melted with sulphate, it has been known for a long time[1] that they are able to retain ponderable quantities of sulphur trioxide. In this case the melt-residuals may be easily recognized analytically, since in sulphate glasses the equilibrium is not shifted as far to the right as in the corresponding carbonate glasses.

Of other melt-residuals, such as sodium carbonate, much less is known. In basic melts, to be sure, equilibria between carbonates and silicates have been observed by different investigators and studied by N. M. von Wittorf[2] and also by P. Niggli,[3] but similar reports are completely lacking in the case of acid silicates. In connection with the problem of "gases in glass," Washburn[4] and his associates, and especially Salmang and Becker,[5] have been able to throw valuable light on this point. It has hitherto been impossible, however, to study these reversible equilibria experimentally, since the quantities of carbon dioxide present in glass lie at the limit of analytical recognition.

An exact study of these melt-residuals, their equilibria in the glass, and the influence of external factors on these equilibria, is frustrated, as has been stated, by the fact that the changes in their magnitudes are too slight to be observed and reproduced with sufficient certainty by analytical means.

Accordingly the task has been set of investigating the reactions of gases, particularly carbon dioxide, with silicate melts under high pressure,[6] since a rise in the carbon dioxide concentration shifts the equilibrium toward the carbonate side and this enables analysis to reach less erratic results.

II. Apparatus and Procedure

For this investigation, an apparatus was available which was able to attain in a bomb a gas pressure of several thousand atmospheres. In Fig. 1, which shows the general scheme, its method of operation is briefly displayed. The pressure-bomb contains a small furnace and is connected to a U-tube. The latter contains 30 kilograms of mercury as a retaining fluid, which transmits to the gas the oil-pressure developed by a hand pump. Pressures up to 800 atmospheres are reached directly with the oil pump,

---

[1] Pelouze, *Compt. rend.*, **60**, 985 (1865); F. Gelstharp, *Trans. Amer. Ceram. Soc.*, **14**, 665 (1912).

[2] v. Wittorf, *Z. anorg. Chem.*, **39**, 187 (1904).

[3] P. Niggli, *ibid.*, **84**, 229 (1914).

[4] E. W. Washburn, F. F. Footitt, and E. N. Bunting, Univ. Illinois, *Bull.*, No. 118 (1920).

[5] Salmang and Becker, *Glastech. Ber.*, **5**, 520 (1927–28); **6**, 625 (1928–29); **7**, 241 (1929–30).

[6] Weyl, *Glastech. Ber.*, **9**, 641 (1931).

and the higher pressures by means of a multiplier. This multiplier consists of a double piston, in connection with two cylinders whose diameters are so related that an increase of pressure to 7.8 times the original is attained. A large hydraulic press of 250 tons capacity connected with a pressure

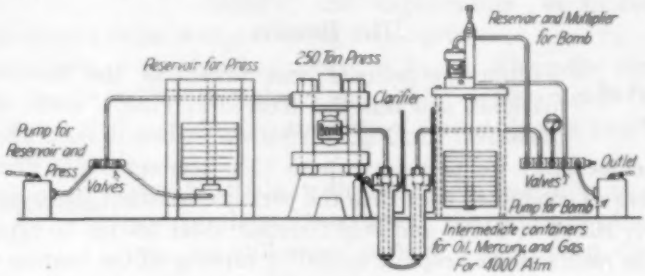

FIG. 1.

storage serves to seal the bomb, when a lid with a copper gasket is pressed upon the bomb.

The pressure-bomb (Fig. 2) of chrome-nickel steel has a hole in the side, into which is screwed the tube for leading in the gas, with a steel cone for a gasket. The bomb itself contains an electrically-insulated conductor for the heating current, and the head of the bomb, two such leads for the thermoelement. The inside-wound furnace, *O*,[7] is well insulated with Marquardt porcelain in a tube, *R*, which fits tightly to the walls of the bomb. In this tube rests a base, *B*, of brass, to which the graphite contact, *G*, is threaded. The path of the current leads through this brass base and out through the bomb itself, to the other end of which the heating coil is fastened. The crucible, *T*, which contains the material being investigated, is formed into a "heat cup," *i.e.*, the platinum platinum-rhodium thermocouple wires are welded directly to its wall.

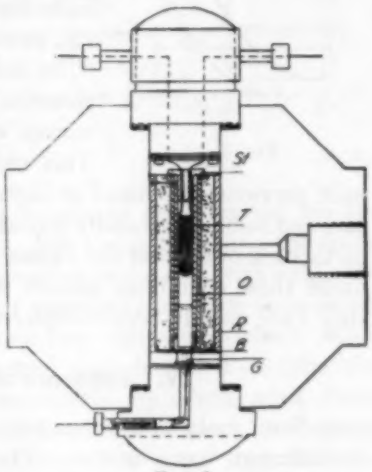

FIG. 2.

The furnace, built on the inside-winding principle, will attain at pressures of 1200 atmospheres a temperature of 1450°C, if care is taken not to allow too strong currents of gas to pass through. To this end the furnace is closed by a well-fitted stopper of fired steatite and cemented with a thick layer of Marquardt mass.

[7] Weyl and Bischovsky, *Chem. Fabrik.*, **4**, 469 (1931).

Without going into details as to the method of working, especially as to the difficulties encountered in the insulation of the thermocouple leads and securing accuracy under conditions of high pressure and temperature, only the most essential results of the investigation will be presented.

III. Results

(1) Effect of Pressure

Sodium metasilicate was taken as the first starting material, and this was treated at 1100°C under different pressures. In Fig. 3 is shown carbon dioxide absorption at this temperature for pressures up to 1250 atmospheres. The experiments were so conducted that with the pressure constant the temperature was slowly raised to 1100° and held constant there for ten to fifteen minutes. The melt was then rapidly cooled by turning off the heating current.

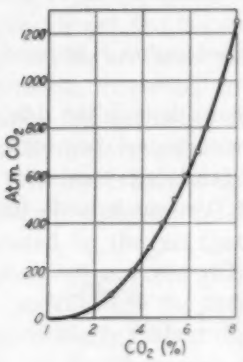

FIG. 3.

Under the high gas pressure cooling took place so quickly, because of the high heat conductivity of the compressed gas, that the melt cooled glassy, in spite of the strong tendency of sodium metasilicate to crystallize. In this manner glasses with a carbonate content as high as 20% were obtained. This is the more remarkable, since it has been found by experimental work with silicate melts that sodium carbonate acts as a mineralizer, *i.e.*, increases the rate of crystallization.

To make certain that the values obtained represented true equilibria, several points of the curves were arrived at from the opposite side. This was done by treating at lower pressures a melt previously obtained at higher pressures. A mixture of sodium disilicate and sodium carbonate was also used in part as starting material. Both methods showed that the values obtained are easily reproducible, and that under these conditions molten silicates are not as inert toward gases as they have usually been considered.

IV. Influence of Change of Temperature

Sodium metasilicates under constant pressure (CO_2) were brought to different temperatures. The results are summarized as follows:

p = 750 atm. CO_2

Experiment	Temperature (°C)	CO_2 taken up (%)
1	1050	7.2
2	1100	6.6
3	1200	6.1
4	1300	5.8
5	1400	5.6

These trials establish the fact that the reaction with carbon dioxide is hindered by increase of temperature.

(1) Effect of Increasing Silica To find application to commercial glasses, which correspond approximately to trisilicates in their acidity, the experiments were extended to sodium silicate melts with increasing SiO_2 content.

A summary of the results appears in Fig. 4, where the absorption of carbon dioxide at 750 atmospheres and 1150°C is shown in per cent. The curve shows that considerable amounts of carbon dioxide may react even with acid glasses.

(2) Potassium Silicates Similar trials with potassium silicates of increasing acidity show that, under the same conditions, these take up still more carbon dioxide than do the corresponding sodium silicates. The high viscosity of the potassium silicate melts has prevented thorough investigation of the equilibrium, since it was not possible to melt the glasses completely free from bubbles.

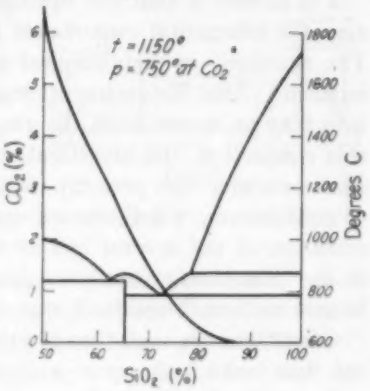

FIG. 4.

Under the microscope, the carbon dioxide-bubbles show a reaction-border, consisting of strongly double-refracting crystals of potassium carbonate. Due to the high viscosity of the molten potassium silicate a bubble of compressed carbon dioxide is formed, which, upon cooling, reacts with the glass forming potassium carbonate. The potassium carbonate at lower temperatures displaces the reaction-equilibrium toward the carbonate side. For the same reason the surface of the contents of the crucible are also found to be covered with a thin crust of carbonate, since here a supplementary reaction takes place upon cooling.

(3) Lithium Silicates Further trials with soda-lime silicates yielded similar results. Lithium silicates, also included in the field of operations, gave measurable equilibria with carbon dioxide. To be sure, the equilibria differ in this respect, that lithium metasilicate takes up only about one-thirtieth as much carbon dioxide as the corresponding sodium compound does. Lithium disilicate shows no noticeable reaction with carbon dioxide at all.

V. CO_2 Chemically Combined

It is seen, then, that the three alkali silicates investigated in general behave similarly, but that, nevertheless, they exhibit considerable differences

in degree, the explanation of which may be related to their different chemical affinities. These differences also deny the assumption that the carbon dioxide exists in the melts in the form of a physical solution, for it is not apparent why silicate melts of similar composition should behave differently toward an inert gas. As the mainstay of a chemical point of view, the crystallization of potassium carbonate in an acid silicate glass was obtained.

Now that the most essential results of the experimental work have been discussed, it may reasonably be asked to what extent such a physicochemical investigation is of importance to the glass technologist. Are the melt-residuals which may be accepted as present in glass of any influence, since their mass, at any gas pressures encountered in practice, is vanishingly small?

The answer is that the equilibria between gas phases and silicate melts are of fundamental importance for a whole series of technical processes. The reactions in metallurgical processes in the blast furnace should be recalled. Also, for geological matters, the same sort of gas equilibria come into play as shown from the gas content of naturally fused magmas. In this connection, the investigation of the reactions of carbon dioxide with silicates under high pressures is taken only as a type of such establishment of equilibrium, which seemed especially suited to the quantitative determination of the several factors which influence the predominant equilibrium. Whether or not great importance should be attached to the carbonate as a melt-residual, was not a determining factor in the research.

Conditions are such that physical chemistry, when joined to a technical art that looks back upon centuries of experience, in the main, can serve only by clarifying the facts of previous experience. There is today in practice no lack of phenomena concerned with an interchange between furnace atmosphere and glass melts. The planing or fining of glass no doubt occupies first place in this regard.

It would go far afield to open this problem for broad discussion; moreover, it involves so many distinct examples, such as equilibria and reactions between carbonates, sulphates, sulphides, oxides, and silica and silicates, that it would scarcely answer the purpose to select such a complex example.

Closely related to planing, and hardly less important, are the phenomena connected with the coloring and decolorizing of glass. Since in decolorizing, an attempt is made to change the state of oxidation of the iron, that is, to displace the oxidation-equilibrium, it is here that the equilibrium of the oxidizing and reducing components enters the problem. On this subject, little has hitherto been discovered.

The gas analyses of Washburn, Footitt, and Bunting, as well as those of Salmang and Becker, indicate definitely that baryta glasses are characterized by a certain oxygen content, and also that there seems to be a

parallelism between barium content and oxygen in the glass. It has not yet been demonstrated, however, that there is a chemical equilibrium to deal with, therefore, with the presence of barium peroxide as a melt residual. According to the above researches this appears probable, since barium carbonate or hydroxide heated in a current of air forms barium peroxide at about 500°. The reaction, $2\ BaO + O_2 = 2\ BaO_2 + 37$ cal., is aided by the presence in the mixture of oxygen-yielding material such as saltpeter. Since, however, this synthesis proceeds exothermally, the formation of barium peroxide is reversed by rise of temperature. At about 800° its oxygen decomposition pressure reaches one atmosphere. Barium carbonate must therefore be regarded as a medium which retains the oxygen liberated by nitrates or chlorates at lower temperatures, until higher temperatures are reached, and then releases it for work. As a matter of fact, the researches of L. Springer[8] have shown that potassium chlorate alone cannot convert FeO into Fe_2O_3, but that the case is at once altered if barium peroxide is added to the mixture. Barium may therefore be likened somewhat to arsenic in its two stages of oxidation. It is obvious that the coloring of glass may also be influenced by this sort of oxidation-equilibria of melt-residuals.

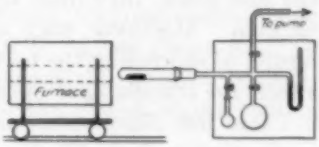

FIG. 5.

Examples in which equilibria between furnace atmospheres and melts play an outstanding part might be added at will. Mention will be made here only of the work of Zschimmer[9] and of Jebsen-Marwedel and Becker[10] concerning sulphate in glass. If also, as Salmang succeeded in establishing, a content of sulphate in finished glass certainly does not weaken its chemical resistance, nevertheless, during the melting process the sulphate content furnishes a measure of the danger of seed formation. It is noticeable in mechanical glass working, that an unusual lessening of sulphate content is accompanied by a change in viscosity. Nothing needs to be added concerning the meaning of viscosity for mechanical operation or concerning the importance of securing there a product of constant viscosity.

The condition of equilibrium of the melt-residuals plays a rôle, and is well worth further investigation, although the absolute mass of such components is not equally important for all applications. In this connection, the demands made upon glass by high-vacuum technique and the lighting industry should be examined. Here a glass is emphatically demanded that is free from such melt-residuals as are in condition to give off gases at high temperatures or under the influence of a bombardment of electrons. As

[8] Springer, *Sprechsaal*, **50**, 166 (1917).
[9] Zschimmer, Zimpelmann, and Riedel, *ibid.*, **59**, Nos. 21–26 (1926).
[10] Jebsen-Marwedel and Becker, *ibid.*, **63**, 874 (1930).

was demonstrated by this study of carbonate-bearing glass by means of a tensimeter (Fig. 5), a reaction begins at as low a temperature as 200°C between carbonate and silicate by which CO_2 is evolved. The gas evolution is especially strong at the point where the glass tube has to be heated to its melting temperature in sealing the flask off from the pump-connection. This hazard has necessitated in several cases the use of vacuum-melted glass[11] in the pump-stem.

It is perhaps significant for the whole status of the problem that these melt-residuals were first observed by the physicists, who also first attempted to remove them completely from glass by electrolysis and by bombardment with electrons and ions. The researches which were carried out by Pirani,[12] Pirani and Lax,[13] and Schirmann,[14] are cited here.

Gases issuing from glass are harmful to electric lamps in two ways. In the first place, they limit the efficiency of the lamp since they ruin the vacuum. Moreover, they also cause destruction of the filament. This results in shortening the useful life of the lamp; also, the sublimed metal affects the transparency of the glass and thereby the efficiency of the lamp.

These few illustrations may suffice to indicate the importance of investigating molten silicates in their relationship to the gaseous phase.

[11] L. S. Vello, Brit. Pat.; *Chem. Zentr.*, **2**, 393 (1924).
[12] M. Pirani, *Z. Physik*, **9**, 327 (1922).
[13] M. Pirani and E. Lax, *Z. tech. Physik*, **3**, 232 (1922).
[14] M. A. Schirmann, *Phys. Z.*, **25**, 633 (1924); **27**, 659 (1926).

THE "MOISTURE EXPANSION" OF GLASSES[1]

By Lowell H. Milligan and David Armitage

ABSTRACT

Changes in the overall length of bars, about 4 by $^3/_4$ by $^1/_8$ inches in dimensions, made of plate glass, Pyrex glass, and various glasses such as constitute bonding agents in vitrified grinding wheels, were studied by means of a Zeiss optimeter that could be read to hundred thousandths of an inch. The bars were measured, then heated for one hour in (*a*) saturated steam at 150 lb. per sq. in., or (*b*) air oven at 184°C, and then allowed to cool to room temperature and remeasured. No increases in length of any of the bars were found within the experimental accuracy of the results (about 0.0015%).

I. Introduction

In a recent paper by H. G. Schurecht and G. R. Pole[2] data are given that show dimensional changes of various ceramic finishes produced by heating in steam at 150 pounds for one hour. They found this treatment to cause an average expansion in lustrous glazes of 0.004%; in mat glazes, 0.011%; in vitreous slip finishes, 0.005%; and in porous slip finishes, 0.033%. The experiments were made on solid bars of the glazes, approximately 1 by 1 by 6 inches in size.

The measurements reported in the present paper were made to study this "moisture expansion" for various glasses, some of which might well be similar to the lustrous glazes of Schurecht and Pole. Two of the samples chosen represented commercial glasses; others were glasses such as constitute the bonding agent in vitrified grinding wheels.

II. Method and Results

The method employed was somewhat different from that of Schurecht and Pole. A Zeiss optimeter was used for the measurements which were made on the overall length of bars of the glasses. The bars were about 4 by $^3/_4$ by $^1/_8$ inches in dimensions. They were ground to parallel sides, the ends were accurately ground and lapped, and their lengths were measured to within 0.00001 inch. The lengths of all bars lay between 3.9620 and 3.9623 inches. Individual measurements were reproducible within about ± 0.00006 inch or ± 0.0015% of the length of the bars.

One set of bars was placed in an autoclave and treated with 150 pounds of saturated steam for an hour. Another set was placed in an oven at 184°C (approximately the temperature of steam at 150 pounds per square inch) for an hour. The bars were then allowed to cool to room temperature, after which they were placed near the optimeter for several hours

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[1] Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Terra Cotta Division). Received January 7, 1932.

[2] *Jour. Amer. Ceram. Soc.*, **14** [4], 313 (1931) and Bur. Stand., *Jour. Research*, **6**, 457 (1931).

TABLE I

GLASS BARS HEATED IN 150 LB./SQ. IN. OF STEAM FOR 1 HOUR

Glass bar	Reference time	Readings (in. × 100,000)
Pyrex glass	11 A.M. before treatment	105, 104
	4 P.M. after "	93
Norton glass No. 1	11 A.M. before "	95, 95
	4 P.M. after "	98
" " No. 2	11 A.M. before "	99, 95
	4 P.M. after "	98
" " No. 3*a*	11 A.M. before "	105, 101
	4 P.M. after "	106
" " No. 3*b*	11 A.M. before "	105, 100
	4 P.M. after "	103
" " No. 4	11 A.M. before "	100, 95
	4 P.M. after "	102
" " No. 5	11 A.M. before "	90, 84
	4 P.M. after "	92
" " No. 6	11 A.M. before "	103, 97
	4 P.M. after "	100
Plate glass	11 A.M. before "	80, 77
	4 P.M. after "	79
Norton glass No. 7	11 A.M. before "	106,100
	4 P.M. after "	100
" " No. 8	11 A.M. before "	104, 99
	4 P.M. after "	95

and then remeasured. Two Pyrex bars were held out to use as checks on the measurements, and the optimeter was also checked several times against Johansson gage blocks during the course of the experiment.

The data obtained are given in the tables. Measurements to hundred-thousandths of an inch, even under carefully controlled conditions, are difficult to make. In the present work the bars were slid between a

TABLE II

GLASS BARS HEATED IN AN OVEN AT 184°C FOR 1 HOUR

Glass bar	Reference time	Readings (in. × 100,000)
Pyrex glass	11 A.M. before treatment	102, 104
	4 P.M. after "	101
Norton glass No. 1	11 A.M. before "	85 to 90*, 85 to 90*
	4 P.M. after "	90 to 94*
" " No. 2	11 A.M. before "	95, 95
	4 P.M. after "	96
" " No. 3*a*	11 A.M. before "	95, 94
	4 P.M. after "	97
" " No. 3*b*	11 A.M. before "	97, 92
	4 P.M. after "	96
" " No. 4	11 A.M. before "	100, 99
	4 P.M. after "	101
" " No. 5	11 A.M. before "	105, 100
	4 P.M. after "	100
" " No. 6	11 A.M. before "	94, 90
	4 P.M. after "	90
Plate glass	11 A.M. before "	78, 71
	4 P.M. after "	74
Norton glass No. 7	11 A.M. before "	104, 101
	4 P.M. after "	98

* This bar was slightly warped and could not be exactly measured.

cast iron plane surface plate and the rounded diamond contact of the optimeter, until they came against a V-block mounted at right angles to the surface plate. This operation was repeated six or more times, and the readings observed. There was a general tendency for the readings to decrease as the repeated sliding gave better contact between the ends of the bar and the surface plate and the diamond. Observations were made until the readings were thought to be approximately constant, and the value thus obtained was then tabulated. The "reading" is the

TABLE III

ZEISS OPTIMETER READINGS ON REFERENCE BLOCKS AND BARS

Johansson Gage Blocks
(Set-up for 3.96200 in.)

Date	Time	Reading (in. × 100,000)	Room temp. (°C)
6/4	10:19 A.M.	75	24.0
	10:44	70	24.0
	10:53	70–75	24.0
	11:10	70–75	24.0
	11:20	70	24.0
	4:00 P.M.	75	26.0
	4:27	75	26.0
	4:48	75	26.6
6/5	9:00 A.M.	74	25.2

Rated thickness of a gage block set-up (in.)	Difference (in. × 100,000)	Reading (in. × 100,000)	Difference (in. × 100,000)
3.96200		+ 74	
3.96100	100	− 21	95
3.96300	200	+180	201
3.96200	100	+ 80	100

Pyrex Glass Bars (not heated)

Bar No.	Reference time	Readings (in. × 100,000)
1	11 A.M.	106, 101, 105, 103
	4 P.M.	100, 99, 98
2	11 A.M.	102, 104, 102
	4 P.M.	100, 98, 98

numerical indication on the scale of the optimeter, and, of course, in order to convert readings into bar lengths it is necessary to add a constant corresponding to the exact length at zero reading of the instrument.

The bars were marked so as to be measured in the same position each time, but absolutely constant readings could not be obtained even on the set of Johansson gage blocks used for reference, as will be seen by consulting Table III. The method of summarizing the data in Table IV is somewhat unusual but aims first to illustrate the accuracy with which readings can be duplicated as measured by the difference between two readings on the same bar, and then to compare this with a similar difference between readings taken before and after treatment.

III. Conclusion

The data in Table IV are considered to show that neither the treatment for one hour in 150 pounds of saturated steam nor in an oven at 184°C produced an expansion of the glass bars that remained after they had

TABLE IV

SUMMARY OF DATA ON GLASS BARS

	Steam heat (150 lb. steam, 1 hr.)		Dry heat (184°C, 1 hr.)	
	Variation of 2 determinations made "before treatment" (in. × 100,000)* (from Table I)	Diff. between av. "before treatment" and the "after treatment" detn. (in. × 100,000)* (from Table I)	Variation of 2 determinations made "before treatment" (in. × 100,000)* (from Table II)	Diff. between av. "before treatment" and the "after treatment" detn. (in. × 100,000)* (from Table II)
Pyrex glass	1	−12**	2	−2**
Norton glass No. 1	0	+ 3	5	+4
" " No. 2	4	+ 1	0	+1
" " No. 3a	4	+ 3	1	+2
" " No. 3b	5	0	5	+1
" " No. 4	5	+ 4	1	+1
" " No. 5	6	+ 5	5	−3
" " No. 6	6	0	4	−2
Plate glass	3	0	7	−1
Norton glass No. 7	6	− 3	3	−5
" " No. 8	5	− 7		

Reference Bars Not Tested

	Variation of 3 or 4 determinations (11 A.M.)	Variation of 3 determinations (4 P.M.)	Diff. between av. 11 A.M. and av. 4 P.M. determinations
Pyrex No. 1	5	2	−5**
" No. 2	2	2	−4

* 0.00006 in. = approximately 0.0015% of the length of the bars.

** + (plus sign) represents an apparent expansion; − (minus sign), an apparent contraction.

reached room temperature. The limit of accuracy of these measurements is thought to be around ± 0.00006 inch, or ± 0.0015% of the length of the bars. One value for a Pyrex bar heated in steam indicates a decrease in length, but this is thought to be due to an extra large experimental error, rather than to any true effect of the moisture treatment.

NORTON COMPANY
WORCESTER, MASS.

THE FORM OF CRACKS IN BOTTLES[1]

By F. W. Preston

ABSTRACT

This paper deals briefly with the stress systems and fracture systems in bottles, or more generally in hollow cylindrical or tubular articles of glass or other brittle materials. The forms that the fractures typically take are described and their causes given.

I. Introduction

Bottles may crack from several causes, (1) getting hit, (2) defective annealing, (3) stones in the glass or similar gross inhomogeneities, (4) small scale inhomogeneities ("cordy," "reamy," or "lappy" glass), (5) thermal shock, or (6) excessive internal pressure.

(1) The glassmaker is not much concerned about bottles being struck.

(2) There is too much fuss made about defective annealing by ignorant purchasers. Any average commercial annealing is just as good as optically perfect annealing and often better for industrial purposes. The use of polariscopes, ignorantly used in this connection, ought to be a punishable misdemeanor.

(3) and (4) Stones and similar inhomogeneities are a frequent nuisance, but inspection can detect them, and the forms of resulting fractures are essentially bursting-stress fractures, similar to those made by pressing a ball or odd-shaped weapon on the glass, except that the pressure arises internally.

The main causes of breakage, as far as the manufacturer is concerned, are (5) and (6), and of these, bursting from thermal shock is generally associated with small-scale heterogeneities (cordy glass), while (6) excessive internal pressure, is the customer's fault, though he commonly complains to the manufacturer.

Some consideration of the forms of the fractures arising from thermal shock and internal pressure are presented and the theory of their origin is indicated.

II. Internal Pressure

A bottle, especially one of circular cross-section and more or less cylindrical in a vertical direction, is, when subject to internal pressure, under much the same system of stresses as is a typical steam boiler. The stresses in a thin-shelled steam boiler are a favorite theme with teachers of juvenile engineering students, so that if the bottle is thin-walled, it is not necessary to elaborate on the theory.

The tension lengthwise of the bottles is not equal to the circumferential

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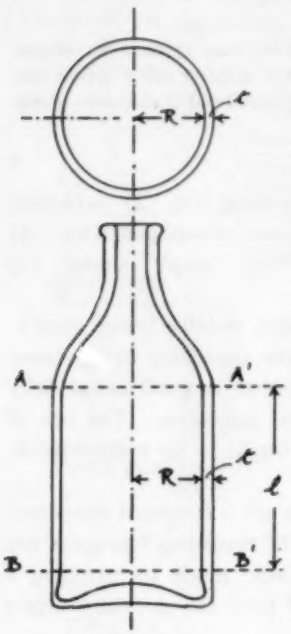
[1] Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Glass Division). Received December 19, 1931.

tension. The former tends to crack the bottle around the periphery; the latter tends to split it lengthwise, the crack in either case being (initially, at any rate) at right angles to the stress.



FIGS. 1 AND 2.

Consider a cross-section of the bottle, and let the pressure in the fluid be p and the longitudinal tension be f_1. The total pressure tending to blow off the end of the bottle or to crack it circumferentially around the middle is $\pi R^2 p$. The resisting area is approximately $2\pi Rt$, and the resisting tensile force is $2\pi Rtf_1$, assuming f_1 is uniform over the cross-section.

For equilibrium these two are equal, so

$$2\pi Rtf_1 = \pi R^2 p \quad \text{or} \quad f_1/p = R/2t \qquad (1)$$

The other (vertical) section of the bottle (Fig. 2) is now to be considered, particularly that part between the planes AA' and BB', separated by a distance l inches. The stresses acting perpendicular to the paper across the side walls AB and $A'B'$ are to be considered. Let this tensile stress be f_2. It has an area of glass $2lt$ to operate on, so the total tensile force perpendicular to the paper between the planes AA' and BB' is $2ltf_2$. Now the fluid pressure to be supported is (pressure times area $AA'\ B'B$) or $pl2R$.

Equating the two

$$f_2/p = R/t \qquad (2)$$

From (1) and (2) it follows that $f_2 = 2f_1$, or that the stress tending to split the bottle vertically is twice as great as that tending to crack it peripherally. This is the well-known steam boiler exercise.

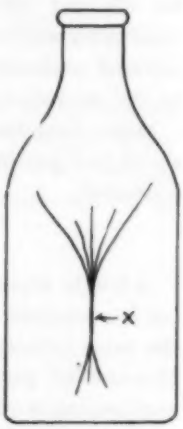


FIG. 3.

We have not considered whether any modification is necessary due to the Poisson ratio effect, but it is sufficient to know that for a given fluid pressure, the bottle, unless very self-willed, will split vertically before it will crack circumferentially.

Typically, then, the crack is as in Fig. 3, originating at x and generally forking considerably. The bottle is likely to be found in fragments, but the tragedy may be reconstructed and the form of the fracture rendered obvious.

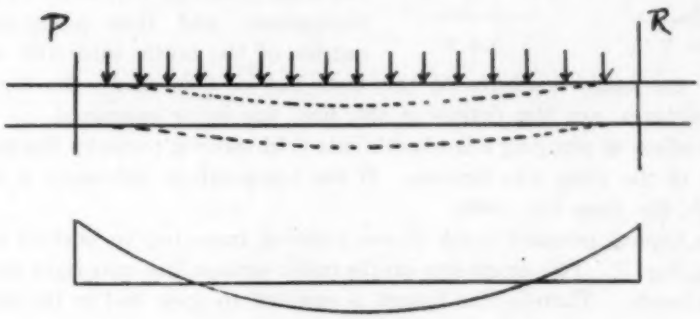
A bottle or jar, perhaps square in section, which has a very thick rigid bottom as shown and weak corners at the base of the sides, is next studied.

Above PP' the walls of the jar are thick and strong as a rule, so that under fluid pressure this part of the jar will not expand much. Similarly the base RR' is even more so, and will not expand. But at QQ' the bottle would like to "belly out" under the internal pressure. But this part of the bottle is rigidly attached to the upper and lower parts. It is therefore in the position of a beam, rigidly fixed at each end, and loaded uniformly over its length (Fig. 5).

FIG. 4.

This is a standard form of loading and the bending moment diagram is as shown in Fig. 6. The greatest bending effort comes at the fixed ends of the beam, where it is twice as great as (and of opposite sign to) that at the center of the span. In between there are places of zero flexure.

If the beam is of uniform section, the stress at any point is proportional to the bending moment there. In the case of this bottle, then, it is evident that the flexing stress is high at the planes P and R, and it may become particularly so at R, due to the fact that in some bottles the glass wall becomes thin at these points. The effect of such thinning is complicated. In the first instance a thin section is poorly able to carry the load, but in the second place, the thinning confers a flexibility that may help to pass the load on to other sections to some slight extent. The net effect, however, is generally hard



FIGS. 5 AND 6.

on this section, and consequently there is a possibility of the glass cracking at this point.

Such a crack will be peripheral, tending to crack the bottom completely out of the jar, and as is obvious from the diagrams above, the fissure opens on the inside of the jar, which is in tension at this section while the outside is in compression.

Cracks of this sort rarely fork. They are not common, unless the corner section is very weak, because in the case of a bottle the "beam" is not free

to flex, being to all intents supported throughout its length by the adjacent sides of the bottle. In the case of a round bottle, the cracks are particularly uncommon, since the vertical face of the bottle must split before the flexure can come on the basal corner. It will, however, be often observed that when the bottle *has* split (as in Fig. 3), one of the fissures will run around the base and largely separate it from the sides as a secondary effect.

III. Fracture Produced by Thermal Shock

It is perhaps particularly desirable that the forms of such fractures should be examined, inasmuch as attempts are likely to be made to standardize tests for "thermal endurance" and it should be determined whether the form of the fracture in any instance is to be regarded as normal or suspicious. Tests for thermal endurance, on a purely empirical basis, are routine affairs in most container plants, and are of far more use than the polariscope as ordinarily employed.

FIG. 7.

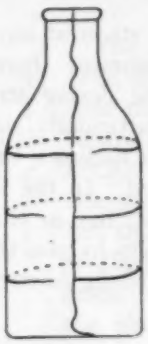


FIG. 8.

The typical "shock" test consists in filling the interior of the bottle wholly or partially with a hot fluid (commonly hot water), waiting till the bottle is hot throughout, and then plunging the outside of the bottle into cold water. There are many variants of the test, but in this study the forms of the fractures, not the details of the test, are being examined.

The effect of plunging a hot bottle into cold water is to throw the outside layers of the glass into tension. If the temperature difference is severe enough, the glass will crack.

The typical primary crack is one running from top to bottom of the bottle, Fig. 7. This originates on the outer surface, but cuts right through to the inside. Thereby the fissure is enabled to open and in the absence of a bottom to the bottle, the circumferential stresses could thereby be completely relieved by this single crack.

FIG. 9.

It will therefore be obvious that when the crack approaches the base of the bottle, it will not tend to cut diametrically across it, but will rather bend to one side or the other and then run peripherally round the bottom, nearly or quite cutting it off. (Fig. 7.)

But though the peripheral tension can be entirely relieved by a single crack of this sort, the longitudinal tension cannot. A single peripheral

crack around the middle will relieve the longitudinal tension only for a short distance up and down from the crack. To relieve this tension with any completeness, the bottle must split into a number of short lengths like so many collars. (Fig. 8.) These peripheral cracks start from the primary longitudinal cracks at right angles, and run more or less completely around the bottle.

Like the primary crack, they run in the first instance on the outside of the bottle, and it is not theoretically necessary that they should go completely through to the inside. While in the first instance the crack is on the outside, later, as the heat distribution evens up, there is a tendency for the crack to run about equally on inside and outside, due probably to the tension on the inside produced by incomplete annealing. The head of the fissure is then fish-tailed, as in Fig. 9.

When customers complain about their bottles breaking, it is well to examine these points.

BUTLER, PA.

A NOTE IN THE CONCEPT OF BRITTLENESS[1]

By F. W. Preston

ABSTRACT

Attempts have been made to define the brittle state, or at least to explain it, in terms of physico-chemical structure. It is generally assumed, however, that the reader knows just what is meant by brittleness, and the definitions dealing with its mechanical aspect are somewhat perfunctory. In this paper, the mechanical properties are briefly described. Brittleness is a property of the fracture system rather than of the material, and is not connected directly with physico-chemical constitution, since certain crystalline and amorphous materials share it, while other crystalline and amorphous materials do not show it.

I. Introduction

Every one knows in a general way what is meant by brittleness. Carrots are brittle as vegetables go, and cast iron is brittle among the ferrous alloys. Porcelain is more or less brittle; in fact all ceramic ware is brittle, so much so that ceramics might be defined as the study of brittle substances. But the most brittle of all is glass. Perhaps this is not entirely true, for quartz is just as brittle.

The property of brittleness has not, however, as far as the writer knows, been defined in any precise terms.

It is extraordinary that while glass in the hot state is one of the most indefinitely ductile materials known, in the cold state it loses all ductility and becomes so characteristically brittle. "As brittle as glass" is a proverb. The two properties are so opposite that one cannot but marvel that a single substance can possess both, and possess them in so perfect a fashion, at two different temperatures. Yet, strangely enough, there seems every reason to believe that they are both manifestations of the same thing.

The metals are not like that. Cast iron is brittle, as metals go; in fact, it is not wholly metal, being partly graphite. Yet cast iron can be permanently dented by a hard steel ball without cracking and at no temperature is it ductile. When it ceases to be brittle it melts to a fluid. Gold is ductile, but it would be hard to blow it into a bottle in the same casual way in which glass is blown.

II. Brittleness Not Negative Ductility

Brittleness, however, is not simply the negative of ductility. A material lacking ductility may be merely friable, like soft sandstone, or it may be fragile like unfired clayware, or it may be a jelly. None of these things is, strictly speaking, brittle.

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[1] Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Glass Division). Received January 2, 1932.

The brittle state of glass, as opposed to its ductile state, has been described in physico-chemical terms, as a difference of state of aggregation; but brittleness is not itself a physico-chemical property, for quartz (a crystal) and glass (a physico-chemical jelly) exhibit it equally well. Brittleness is a purely mechanical matter.

III. Qualifications for Brittleness

To qualify as a brittle substance, a thing must normally satisfy the following requirements:

(1) It must fail in tension and not in shear. If subjected to shearing stresses, it must fail from the tensile stresses developed as a consequence and concomitant thereof. The nature and appearance of such fractures have been dealt with elsewhere.[2]
(2) It should have a high value of the elastic modulus.
(3) It should have a fairly high tensile strength.

The reasons for these stipulations follow:

The first is equivalent to saying that the breaking-stress must exceed the flow-stress. In other words, the material breaks before it flows. This rules out all ductile materials.

The second qualification is largely a matter of degree, and is intended to carry with it the implication that the material fails at comparatively low strains or distortions. It is meant to rule out jellies, which satisfy the first condition (that is, they fail in tension), which is by far the most important condition; but jellies are not normally regarded as brittle.

The third requirement is also a matter of degree. If the other two conditions are complied with, but the third is not, then the material is more apt to be friable than brittle. Many sandstones of recent geological age are of this friable character; for instance, many of those along the Chesapeake Bay, well known to American glass technologists. On the other hand, many of the ancient sandstones used for melting sands would qualify rather as brittle materials, for they need considerable crushing.

On the foregoing basis, a number of things will qualify as brittle: glass and quartz, granite, basalt (or most igneous and many sedimentary rocks) brick, refractories, and in fact most kinds of ceramic ware, most abrasives, most oxides, most sulphides, and so on. But few of them will possess the characteristic brittleness of glass and quartz. A fourth condition for the criterion of brittleness par excellence, will therefore be added.

(4) The material must be capable of developing forked fractures from internal stress. That is, a single fissure must be capable of developing "radiants" of fissures. These are rarely seen in granular brittle materials.

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[2] See paper on fissures in glass by the author published in *Jour. Amer. Ceram. Soc.*, 14 [6], 419–27 (1931). See particularly, Fig. 27, p. 426.

They occur in natural basalts, and are frequent in glass. They occur only when the fissure is traveling with explosive violence.[2]

It is this ability to develop forked fissures that makes possible the development of splinters of glass, which are scarcely known in pottery and in other ceramic ware, and makes the breaking of glass so dangerous an operation and its fragments so unpleasant as compared with broken pots. There is scarcely any other substance that can go to "smithereens" as glass does. Pottery can crack; and dried clay can go to pieces. But the violent, explosive, reduction to splinters, and "smithereens" is a property almost confined to the glasses.

STANDARD MANUFACTURING COMPANY
BUTLER, PA.

MICROSCOPIC EXAMINATION OF CERAMIC RAW MATERIAL AND FIRED PRODUCTS, A HELP IN PLANT CONTROL*

By Irma Rhodb and Hermann Harkort

ABSTRACT

Methods and manufacturing control benefit of petrographic analyses are described.

I. Introduction

Since ceramic products are composed of particles so small as to be distinguished only by the microscope, it is astonishing that more use has not been made of the microscope in ceramics, not only for control studies on finished products, but also on the raw materials. When dependent alone on thin sections this was not possible, but such studies are now offered by the immersion method. The immersion method is applicable alike to raw materials and finished products.

Microscopic examination of raw materials is important in plant control. Not that the microscope alone will reveal the solution to every problem, but in connection with other tests it has proved to be of great value.

Microscopic check of the raw materials does not require much time. A chemical analysis takes days; a microscopic analysis, hours.

The microscopic analysis lacks the accuracy of the chemical but it gives a far better idea as to what minerals are present in the sample. It will also reveal the grain size of the minerals.

For several years the authors have made examinations by the immersion method as described by Larsen,[1] Winchell,[2] Spangenberg,[3] and others. This method was preferred as it needs very little material and no special preparation except the powdering of the material. In some cases thin sections were made. The immersion method proved to be more informing, especially in determining new crystal developments, as in grog or finished products.

Note: Oftentimes immersion is superior to the thin-section method since with hard ceramic material it is sometimes difficult to get the necessary thinness for very small crystals. A further disadvantage of the thin-section method is the fact that usually a plant laboratory is not equipped to make thin sections and the samples have to be sent away, which takes time.

It has proved advantageous to make microscopic examinations of residues after igniting clay at 250°C and 1000°C. At 250°C the organic material is burned off, and under the microscope it can be seen whether certain colorings of the sample are due to organic material or to iron.

Having the chemical analysis of a material, it is possible by aid of the microscope to determine whether the alkalis are from feldspar or mica or

* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (White Wares Division). Received November 23, 1931.

[1] E. S. Larsen, U. S. Geol. Surv., *Bull.*, No. 679.

[2] A. N. Winchell, Elements of Optical Mineralogy, 1929.

[3] K. Spangenberg, *Fortschritte der Mineralogie*, 1922.

whether they are adsorbed. It is also possible to obviate exact determinations of CO_2 and S when the microscope shows that lime, sulphates, or pyrite are absent. In some cases the chemical analysis will indicate the presence of free silica in clays, although it is not visible under the microscope as quartz. Often it is the practice in the plant laboratory to limit the chemical analysis of clays to the determination of water, alumina, and silica as a means of estimating the clay substance. This may be misleading especially for clays containing other alumina minerals such as diaspore. Due to the peculiarity of most clays, shipments will not duplicate those preceding; therefore, an exact chemical analysis should not be pressed. Sometimes the variation in the silica in clays will be 5% without a change in the character of the clay.

II. General Information

While microscopic examination of the other minerals is rather simple for a trained petrographer, the examination of clays requires accumulated experience and standard samples.

Clay substance varies mostly in degree of dispersion. Under the microscope it appears like a ball of cotton, usually of an index of refraction of about 1.565. It is possible to compare the dispersion of clays even though it is not possible to determine the degree of dispersion. Highly dispersed clays seem to disappear in the immersion liquid, thus requiring the use of liquids of lower index of refraction to obtain a relief.

That the plasticity is in relation with the dispersion is shown by microscopic observations. It is possible to see whether one clay is more plastic than another, but definite data on this are lacking.

It has been observed also that highly dispersed clay substance tends to cause early development of new crystals, but it is impossible to say whether this is due to dispersion alone or to adsorbed materials such as lime and magnesia. Iron is a strong mineralizer even in less disperse clays.

The most common impurity in clays is quartz. It appears under the microscope in more or less small grains: index of refraction $\epsilon 1.553$, $\omega 1.544$.

The quartz might be present in clays as follows:

(1) Large, coarse grains only (grain size <0.03 mm.), (*a*) clear crystals, mostly rounded, as sharp edges are rare in clays, and (*b*) crystals with undulatory extinction.

(2) Medium large grains (grain size 0.03–0.01 mm.), (*a* and *b*) the same as in (1) but less pronounced.

(3) Small quartz particles (grain size >0.01 mm.), (*a*) free, without close contact with the clay substance, and (*b*) embedded in the clay substance, disclosing some strong adhesive power of that special clay substance.

It is possible that only one of the six types is present, but such cases

are rare. All combinations are possible, but one or two types predominate in a given clay.

The most common fluxes in clays are as follows:

(1)	Calcium-carbonate (limespar)		ϵ 1.486	ω 1.658
(2)	Magnesium-carbonate		ϵ 1.509	ω 1.700
(3)	Dolomite		ϵ 1.500	ω 1.681
(4)	Siderite		ϵ 1.633	ω 1.875
(5)	Gypsum	α 1.520 γ 1.530	β 1.523	
(6)	Feldspar, mostly as sodium feldspar*			
(7)	Mica (muscovite)	α 1.561 γ 1.594	β 1.590	
(8)	Pyrite opaque			

*Anorthoclase	α 1.523	γ 1.531	β 1.529
Orthoclase	α 1.518	γ 1.526	β 1.524

(1) Control Test of Clays It is advisable to set aside a standard sample of each clay used, with a record of its chemical and petrographic analysis. This standard sample and analytical record makes possible a close control of all future shipments.

The character of the clay substance from a given deposit does not vary much, usually having the same dispersion and adsorbed salt content. Those components that vary are quartz and the mineral fluxes. Sometimes shipments from deeper layers or other places of the deposit vary in the proportion and character of admixed minerals. A microscopic examination quickly reveals such variations enabling a control of each shipment before storing the material.

Usually the importance of the variation in size and nature of quartz grains in clays is overlooked. Often a variation of 5% of large quartz grains is sufficient to spoil the ware made, due to the change effected in coefficient of expansion of the ware. In such cases the clay should be washed or used otherwise.

Large quartz grains dissolve in fusion very slowly. To obtain a perfect solution of the quartz grains or a change into tridymite or cristobalite it is advisable to use clay containing medium sized and small quartz particles or large quartz grains with undulatory extinction. If the standard clay contains small quartz particles it is not advisable to use a shipment containing coarse quartz from the same deposit because its workability and firing behavior are changed.

NOTE: Undulatory extinction will appear under the microscope only when crossing the nicols and not using the gypsum plate and by revolving the stage rather slowly. The quartz grain with undulatory extinction will not become black and white all over the surface as does ordinary quartz, but a gray shadow will creep over the grain while turning the table.

When substituting one clay by another, it has proved to be good practice to take the greatest care in getting a clay containing quartz of about the same character, grain size, and amount as in the standard.

It is an interesting fact that it is impossible to substitute quartz in clay.

Added quartz can be distinguished immediately under the microscope from quartz that by nature belongs to the clay. The added quartz usually is far brighter and has sharp edges and distinct conchoidal fracture, while the quartz from clay is rounded, seldom has a clean surface, and usually has pits and holes. That these two types of quartz will behave differently during the firing is obvious. The quartz which is by nature in the clay is less resistant.

The fluxes will influence the firing behavior of a clay; therefore, it is necessary to know their grain size, distribution, and amount. Due to the fact that most carbonates are strongly birefringent they will appear plainly under the microscope and, even in small grain size (as for example, chalk), cannot be overlooked. Sometimes it might be difficult to distinguish gypsum from the carbonates, but the index of refraction of gypsum (1.530) is so far apart from the index of the carbonates that when embedded in liquid 1.530 it is easily possible to make the distinction. Siderite might be taken for pyrite, but if the powder is thinly spread it will be possible to see the birefringence in the siderite crystals since pyrite remains dark in every case.

Feldspar has an index of refraction of about 1.527. The determination of the different kinds of feldspar has been described clearly by H. Insley.[4]

Almost all clays contain mica as an impurity, in most cases as tiny needles sticking in the clay substance, sometimes as plate mica. When turning the needles under the microscope the plate-like shape may be seen though they do not stay long enough with the full plate turned up, but disappear and then again reappear.

Iron may be present as pyrite or absorbed iron. Distinguishing iron particles from carbon under the microscope is sometimes difficult. Pyrite usually has a greenish coloring on the surface while carbon never has. Absorbed iron gives to the clay substance a red-brown color, while absorbed organic material most often gives a darker brown color. To decide whether the coloring material is organic or is iron, it should be ignited at 250°C.

When examining new samples or a new shipment of clay the fluxes should be carefully determined. The effect of soluble salts is well known. The clay should be boiled for a short time with water, dried, the residue weighed, and the nature of the residue determined by the aid of the microscope.

Sometimes the samples show pyrite or mixtures of pyrite and gypsum far larger than usual. This happens often since during the sedimentation of clay some layers are enriched in salts which later develop into crystals. In such cases it is necessary to screen the clay or to grind longer.

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[4] H. Insley, *Jour. Amer. Ceram. Soc.*, 9 [9], 651 (1927).

(2) Control of Degree of Firing When observing 1100°C grog under the microscope it will not be possible to see distinct needles even faintly. When crossing the nicols the single grain appears softly shining, but with a light, foggy veil. By using the same microscope, the same light source, and the same magnification, it is possible to check the amount of light passing through such a fired clay particle. A clay fired at a low temperature (between 900° and 1000°) is in an amorphous state and scarcely any light will pass through. The higher the firing temperature and the larger the crystals are developed, the more will light pass through and the brighter will the grains appear. This is a qualitative measure for the degree of firing.

An even better indicator for the firing temperature is quartz. The smallest particles of quartz disappear at a certain temperature, characteristic for each clay. Quartz particles as small as 0.01 mm. and less will, as a rule, disappear suddenly in the fusion. The medium and coarse particles do not disappear suddenly but alterations begin at their surface. At certain firing temperatures, the medium-to-large quartz grains lose their birefringence and appear isotropic, but are not dissolved in the surrounding clay; they still keep their shape. The larger quartz grains are even less advanced; some of them entirely untouched and some show birefringence inside, while the outer layers of the crystals become isotropic. The coarse quartz crystals which have undulatory extinction are exceptions, as mentioned by Judinson.[5] Undulatory extinction indicates an unstable crystal structure, probably due to geological stress. Such crystals dissolve more easily than do other quartz crystals. Under the microscope such crystals appear to be isotropic or to contain the typical tridymite needles. Clays containing a large amount of such crystals after a firing at about 1200°C will appear rather dull under the microscope (crossed nicols) and only the newly developed mullite and tridymite crystals will give light. The quartz has disappeared entirely.

The presence of undulatory quartz crystals in clay indicates the probability that all the quartz present is less stable.

By having standard firing samples and knowing the firing behavior of a clay, a kiln control by the microscope is possible.

(3) Microscopic Control in Earthenware Production By firing clay samples at different temperatures and examining under the microscope, it is possible to determine quickly the suitability of clay for specific purposes. The quantity as well as the variability of clay resources can be established at a minimum expenditure of money and time by employment of the microscope in examining the raw and fired clay samples from different parts of the deposits.

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[5] Judinson, Feuerfest-Ofenbau, November, 1930.

A microscopic examination should be made of each shipment of clay, comparing it with the standard sample. The moisture and loss on ignition should also be compared with that of the standard.

Fired samples of each shipment will show color changes and, when examined microscopically, will reveal the firing characteristics of the new shipment compared with those of the standard samples.

NOTE: A microscopic analysis alone will not give a grain size analysis except when the observer is familiar with the material and has had much experience. An elutriation analysis plus microscopic examinations of the different fractions give analytical data of great value (see H. Harkort, *Ber. deut. keram. Ges.*, **8**, 6 (1927); **9**, 189, 476 (1928).

A microscopic examination is useful for all the nonplastic components of the batch. It is possible to decide whether new shipments of feldspar or quartz are the same as standard, and whether the whiting contains impurities.

Rational analysis of a Meissen clay gave an unusual amount of feldspar. Microscopic observation proved immediately that no feldspar was present, but another rock residue of glassy, amorphous character, liparite.[6] In such a case a rational analysis is misleading as nothing is known of the solubility of liparite with sulphuric acid or hydrochloric acid.

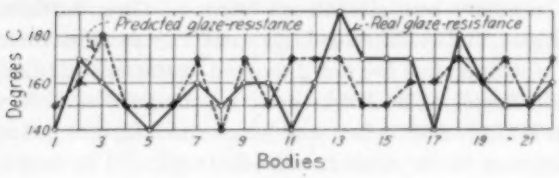

FIG. 1.

Extraordinary results were obtained with this new mineral, results that are so favorable that a larger use of liparite in earthenware bodies has been made. Without the microscope the character of this useful mineral would not have been established.

It should be considered that when mixing the raw materials, any kind of irregularity may cause discrepancies. For plant control, the workability, composition, and firing behavior of the batch when ready and before actual production starts should be made. Microscopic examination of the filter-press cake will show the mineral proportions and grain size of each in the prepared mixtures. Before making any definite decision in this part of the plant control it is necessary to check the material carefully. The microscopic data should be written up in detail and compared with the other plant-control tests, such as (1) workability of the batch, (2) resistance against crazing, and (3) the chipping test.

It is possible to foretell from the microscopic examination, the body re-

[6] EDITORIAL NOTE: Liparite is a rock of rhyolitic character, at one time called porous-trachyte. It is essentially the same in composition as granite, but is of more recent origin. It is made of a glassy material containing phenocrysts of quartz and alkali feldspar. (It is much like lava.)

sistance to crazing and spalling. Figure 1 shows how far these prophecies have come true. The correspondence of the predictions with the results obtained on the finished ware is satisfactory considering that the microscopic examination was done on very small samples from batches of 10,000 kg.

This prediction was based especially on the determination of the amount of quartz in the clay substance and was checked by comparison with standard batches of known properties.

NOTE: The tremendous importance of this type of quartz (smallest particles of quartz embedded in the clay substance) is settled. Today raw materials and batches can be controlled to such a degree that crazing and chipping can be prevented. This control demands a careful storage of every shipment delivered, and the necessity of always having clays in storage to correct faulty shipments. This might seem uneconomic as a large quantity of clay must always be in storage. The faultless output and the constancy of the products, however, justify such a sharp control.

The microscopic control can also be applied to any clay slip just as well as to any other batch. It is only necessary to put a drop of the slip on the object slide and let it dry. The powder is examined in the usual way. In case these slips or batches contain only small quantities of whiting the microscopic observation is difficult since, because of the strong birefringence of the whiting particles, the clay substance and the quartz are often masked so much that it is necessary to treat the powder with hydrochloric acid or to heat it to 600 to 700°C.

The test of the finished products usually is limited to the determination of crazing and chipping. For this purpose samples are placed in those parts of the kiln known to have the lowest and highest temperatures, and are fired in the biscuit as well as in the glost kiln. These samples will give a knowledge of the behavior of ware fired between the extreme temperatures. A microscopic analysis of these samples is advisable, especially if the results of the tests are abnormal. An examination of the powdered sample usually is sufficient, although a thin section will give a better knowledge of the body structure.

III. Microscopic Examination of Other Ceramic Raw Materials

(1) Silica Silica raw material is chiefly SiO_2 with impurities. This SiO_2 is present in different crystal modifications such as colloidal SiO_2, opal, and quartz. According to Judinson[7] the silica best suited for silica brick contains quartz grains not larger than 0.02 mm., and embedded in a cement of opal silica. The opal silica appears under the microscope as tiny crystals of low birefringence and has an index of refraction that is slightly lower than that of quartz. Judinson further declares that a silica containing no opal cement might be suitable for silica brick, provided the quartz grains are not too large and show undulatory

[7] See footnote 5.

extinction. He explains that to obtain in the kiln firing a development of tridymite and cristobalite in silica brick it is necessary to have "weak spots" in the raw material which is either opal cement or quartz with an unstable crystal lattice as shown by undulatory extinction.

The microscopic examination of these silica raw materials can be made on a powdered sample but thin sections give better results.

The chemical analysis of silica materials can be eliminated entirely. The lime and the iron particles show up under the microscope clearly when embedded in liquid 1.545, and by comparing with a standard sample.

By means of the microscope, control tests of the firing of the silica brick are rather easy. Tridymite and cristobalite appear in the glass-matrix vividly when crossing the nicols. Distinguishing tridymite and cristobalite needs much training as these crystals are rather small.

Salmang[8] describes a working and firing scheme to influence the exclusive development of tridymite. He controlled results by the microscope and showed what a great help it will afford when trying new firing schedules.

(2) Cyanite Cyanite, andalusite, and sillimanite are chemically alike. They are distinguishable only by microscopic analysis.

Cyanite	α 1.712	γ 1.728	β 1.720
Andalusite	α 1.632	γ 1.643	β 1.638
Sillimanite	α 1.638	γ 1.653	β 1.642

Cyanite is usually accompanied by quartz. When immersed in liquid 1.720, cyanite disappears almost entirely and the other impurities show up. This will permit the determination of the impurities.

On firing cyanite, the mineral expands, and when using material not fired high enough the finished product will expand when in use. See publications of Bowen and Greig[9] and Peck.[10]

(3) Diaspore Diaspore has an index of refraction[11] of β 1.722. The rock diaspore, especially of Missouri, is accompanied by clay. The mineral particles of diaspore appear quite distinct, especially in liquid having an index of refraction of 1.570, in which the clay disappears.

The size of these diaspore crystals varies, but with experience it is possible to check the amount of the diaspore present in a sample within $\pm$ 10%. Diaspore clay fired at 1000°C looks dull and no crystals are determinable under the microscope. At about 1100° the formation of corundum begins, and, depending on the firing degree, the size of the crystals increases. Associated with this growth of the crystals is a shrinkage of the material. As the grain size of the newly developed corundum is determinable by the microscope, it is possible to determine the firing degree, and also whether the shrinkage of the diaspore has been completed.

[8] H. Salmang, *Ber. deut. keram. Ges.*, **12**, 1 (1931).
[9] N. L. Bowen and J. W. Greig, *Jour. Amer. Ceram. Soc.*, **7** [4], 238; [5] 410 (1924).
[10] A. B. Peck, *ibid.*, **8** [7], 407 (1925); *Amer. Mineralogist*, **9**, 123 (1924).
[11] α 1.702, γ 1.750, β 1.722.

IV. Conclusion

According to the experience of the writers the microscope can be used successfully in plant control. It does not afford remedy for every trouble, but is exceptionally serviceable in making good diagnoses.

A good petrographic microscope which permits a magnification of at least 750 is essential. It also requires a well-trained examiner. Very good microscopes are on the market. The examiner has to have training and patience. It is greatly regretted that the mineralogical and optical training of ceramic students is so much neglected.

CHARLOTTENBURG, BERLINSTR. 66
GERMANY

A RAPID METHOD OF ESTIMATION OF ALUMINA IN CLAYS[1]

By R. W. Ellison

ABSTRACT

With the material analyzed in routine a definite relation was noted between the proportion of combined water and silica. The determination of combined water and of iron was all that was necessary to calculate the silica and alumina. The procedure is given and also a curve showing the relation between combined water and silica in the particular material cited. This same short cut chemical analysis is applicable to other clays when the curve for the ratio of combined water to silica has been determined for each clay.

I. Introduction

In mining fire clay for refractories manufacture, it is of considerable importance to know the iron content and the approximate alumina content of the clay in the bed or stock piles in order to be able to furnish clay that is within the desired specifications.

In the study of an aluminous clay deposit located in Orange County, Calif., a consistent reciprocal relationship was noted between the loss on ignition and the silica content. Since ordinary methods of analysis for alumina would include the iron content and the loss on ignition, it was only necessary to note that the sum of the titania and fluxes were uniformly quite constant to see that if the silica content could be estimated, a rapid method of obtaining the alumina content by simple subtraction would result.

Figure 1 shows the relationship between the loss on ignition and the silica content of a large number of samples; this was used in the estimation of silicas for mining purposes. By using a rapid method of analysis for iron, it is possible to complete an analysis well within two hours' time, inclusive of the preparation of the partly ground sample.

II. The Method

(1) Preparation of the Sample The sample is prepared by grinding the quartered sample in a porcelain mortar to pass a 100-mesh screen. It is then placed in the oven at 105°C for about three minutes and allowed to cool in the room atmosphere for about fifteen minutes, thus rapidly attaining an air-dry condition. This is done as a matter of convenience only, and oven-dried samples could be used but the time of drying would be considerably greater and the convenience of handling, less. Whichever method is chosen should be used constantly and no change made from one method to the other.

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[1] Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Refractories Division). Received November 13, 1931.

See also the paper by M. E. Holmes and W. D. Keller, "The Estimation of the Alumina Content of Diaspore and Burley Clay from the Silica Content," *Jour. Amer. Ceram. Soc.*, **15** [1], 68 (1932).

(2) Loss on Ignition The loss on ignition is determined by weighing a 0.5-gram sample into a weighed platinum crucible and heating over a Méker-type burner for one-half hour, the latter half of the time with the crucible covered. It is cooled in a desiccator, weighed, and the percentage loss is calculated.

(3) Iron A 0.5-gram sample is fused with previously-dried potassium bisulphate in a porcelain crucible until a quiet fusion is obtained at a moderate temperature. When cool, the crucible is inverted over a sheet of paper, the cake is placed in a beaker, and about 25 milliliters of 1:1 hydrochloric acid and about 100 milliliters of hot water are added. The sample is heated to near boiling to dissolve the cake and is allowed to digest for about ten minutes. It is then transferred to an Erlenmeyer flask and a small excess of stannous chloride solution is added to reduce the iron. It is cooled under running water, 10 milliliters of saturated mercuric chloride solution are added, and the sample is allowed to stand a few minutes. Three drops of diphenylamine solution are added and it is titrated to a definite violet color with potassium dichromate solution. The percentage of ferric oxide is reported and calculations are made on the fired basis.

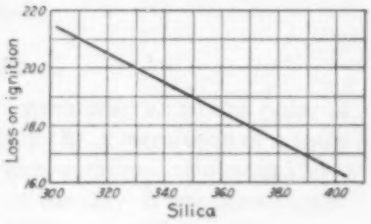

FIG. 1.

(4) Alumina To determine the alumina content, the silica corresponding to the loss on ignition is found on the curve, the ignition loss and ferric oxide added, and the constant value (previously determined) for the sum of titania, lime, magnesia, and alkalis, which in this clay equals 2.2%. The difference between this grand total and 100 represents the alumina content. It is then calculated to the fired basis.

(5) Accuracy The accuracy of the method is largely dependent on the accuracy of the silica values taken from the curve. A comparison of values found by actual analysis with values taken from the curve in the case of 100 consecutive samples reveals the following results:

Errors (+ and −)	(%)
0.0–0.5 inc.	58
0.6–1.0 "	25
1.1–1.5 "	12
1.6–2.0 "	2
Over 2.0	3

Errors (+)	(%)
46 with range of	0.1–1.6
Av. error	0.51
Errors (−)	**(%)**
50 with range of	0.1–2.7
Av. error	0.66

No error in 4 cases
Av. of + and − errors −0.09%

It will be noted that in ninety-five cases the errors were no greater than 1.5%, which is satisfactory for mining purposes. It is believed that the above method can be applied to many other clay deposits with equal success.

THE VITREFRAX CORPORATION
LOS ANGELES, CALIF.

ERRATA

In the paper by W. M. Cohn, on "New Light Source for Absorption Measurements of Glass," *Jour. Amer. Ceram. Soc.*, **15** [2], 123 (1932), a correction of rectified voltage should be made. The first sentence following "III. Spectrum Emitted" should read as follows: "If a rectified voltage of 25,000 $v._{max.}$ is applied between the cathode and anode, a blue glow is observed on the thorium metal, even when a current of only 1 mÅ, flows through the lamp." The voltage was incorrectly printed as 2500.

SOME NOTES ON THE NATURE OF CLAY[1]

By F. H. Norton and F. B. Hodgdon

ABSTRACT

The porosity and particle spacing was determined for a number of plastic and nonplastic materials under various conditions of wetness and pressure. This was done by pressing the material in a cylindrical mold and measuring the resultant density of both the freshly-molded and the dried specimen. The results show that all of the materials at the lower pressures have a critical water content, beyond which the particles re-orient themselves into a denser packing. This point corresponds to the pores being one-half filled. The clays are differentiated from the nonplastic materials by their ability to hold a stable water film onto the surface of the particles. The maximum stable thickness of this film occurs at or beyond the point where the pores are filled, and for the clays tested averages about 3×10^{-4} cm. in thickness. This film is so stable as not to be influenced by pressures as high as 800 kilograms per square centimeter. A size analysis of the particles of all the materials was made, and their average size and diameter computed. All of the materials were found to have some elasticity when the pressure was relieved. These data taken as a whole allow the construction of a comparatively accurate picture of the clay structure.

I. Introduction

Ever since clay has been used, men have speculated as to the cause of its unique properties. Within the last century the modern tools of science have been used to look for the answer to this question. Unfortunately, due to the extremely fine-grained structure of the clay, it has been impossible to observe directly the relations of the clay particles and water. The best that can be done is to build up a hypothetical structure which will most perfectly fit the direct and indirect evidence obtained from various observations on the clay. While some characteristics of this structure such as fine grain size and colloid content are well known, there have been numerous theories advanced to explain the details of plasticity. Indeed, so large in number are these theories that it will be quite impossible to review them here. It will suffice to say that the hypothesis of the structure of clay most generally accepted at this time is that of a fine-grained hydrated aluminum silicate, whose particles are coated with a stable, water-attracting surface.

Various methods have been used to study the nature of clay. Among these may be mentioned the measurement of particle size, viscosity, plasticity, drying shrinkage, dried strength, and colloid content, all of which determine some property of the clay which can be indirectly used to visualize its structure. In the present investigation a simple tool is employed to give an insight into the fine structure of clay. When molecules or atoms, which are, of course, too small to be directly observed, are being

[1] Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (White Wares Division). Received December 9, 1931.

investigated, it is often advantageous to study a large group of individuals rather than a single unit. In many ways the group will have properties directly related to the single individual. For example, the gas laws were determined for a volume containing a large number of individual molecules, and yet they show quite clearly the behavior of the average molecule. Again, it is impossible to measure directly the positions of the atoms in a crystal, but by taking advantage of the X-ray reflection from a large series of atoms, their position can be accurately located. In the same way a careful study of the volume changes in a mass of clay will permit the determination of the behavior of the average clay particles.

If the clay is then subjected to every possible degree of wetness and pressure, and at the same time the manner in which these conditions affect its volume is measured, it will be possible to determine the relative spacing of the average particles. Moreover, the relative spacing can be translated into actual dimensions if the average particle size is known. Similarly, the amount of pore space between the particles can be readily evaluated from the specific gravity of the particles and the bulk density of the clay mass if it is assumed that the density of water in the pores is unity.

Three characteristics of the average clay particle are then available for the purpose of building up a picture of the structure: (1) the spacing, (2) the pore space, and (3) the amount these pores are filled with water. It is quite simple to find a structure that will fit a single condition, but to find one that will fit all takes many trials. The more varied the conditions satisfied by the hypothetical structure, the more probable is its identity with the real structure. It should be emphasized that there are presented here only some probable structures. A complete picture can only be gained when more information is obtained.

The data given here are not new in their nature, as similar values have been obtained by a number of experimenters, but until the density values were obtained with considerable precision a careful analysis was impossible. It is believed, however, that the use of these data to form a picture of the clay structure and to produce a logical theory of plasticity has not been attempted before.

It is unnecessary to give the steps taken to fit one theory after another to the data. The data will be first given in the form of curves and then the types of structure most closely fitting the data will be described.

II. Apparatus and Methods of Testing

The test methods used are of extreme simplicity in theory but from a practical standpoint require most careful manipulation to obtain consistency of results. The problem of producing a homogeneous mixture of a clay and a small amount of water is not without difficulty. In general,

the following procedure was followed: The clay was mixed with water by placing it in a mixer and spraying it with an atomizer while it was being rapidly agitated. In this way the small amounts of water could be added evenly. The samples wet enough to be plastic were wedged up in the usual manner. All samples were then sealed in preserve jars and aged for twenty-four hours.

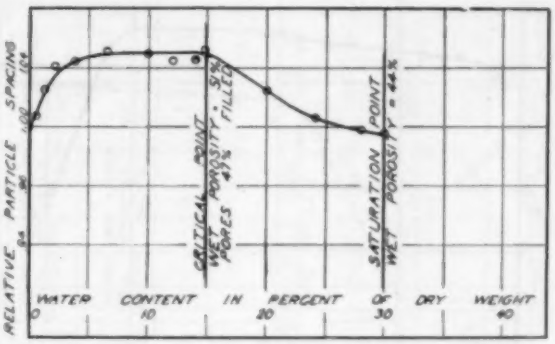

FIG. 1.—Dry-milled quartz.

The manner of treating the dry clay was important as it influenced the degree with which the particle aggregates were broken up. In most cases the clay was dried at 110°C, ball-milled dry for eight hours, and then put through a 100-mesh screen. The English ball clay and the brick clay were first blunged and screened wet to remove the charcoal and sand. It was found that the fineness of the dry clay influenced the height of the density curve but did not greatly affect its shape or slope. Care was taken to make up enough clay in one batch to complete all of the necessary tests.

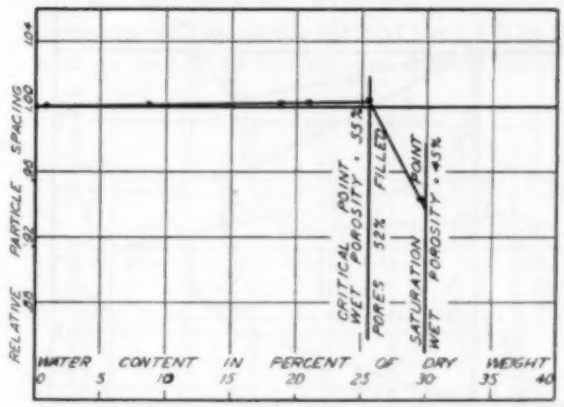

FIG. 2.—Wet-milled quartz.

The tempered clay was placed in an accurately-machined steel cylinder with a loaded top plunger, which formed cakes of clay 7.64 centimeters in diameter and about 1 centimeter thick. The load was applied with a 10:1 lever and the thickness of the specimen was read from a mark on the plunger by means of a micrometer microscope. At the higher pressures the load was applied in a hydraulic press. The thickness of the cylinder was kept comparatively small in order to minimize errors due to side-wall friction.

In most cases it was necessary to apply the load for a considerable length of time before equilibrium conditions were reached. The settling of the plunger could be easily watched through the microscope, and in the case of the wetter specimens over an hour was often required to reach equilibrium. The size of the specimen was measured with vernier calipers and weighed immediately after removal from the mold; these measurements were repeated after the cylinder was dried to a constant weight of 110°C. In the case of the bentonite with high water content, the drying shrinkage was great enough to crack the specimens. Under these conditions the

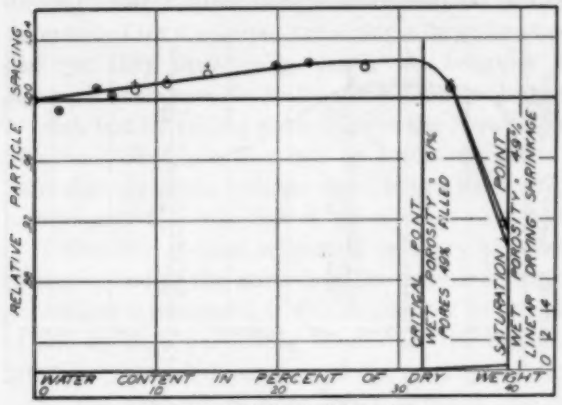

FIG. 3.—Calcined china clay.

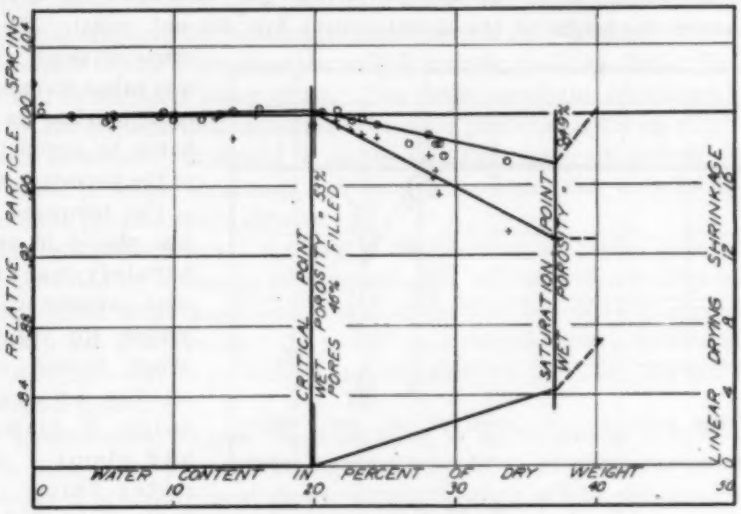

FIG. 4.—English china clay.

volume was obtained in kerosene, and is, therefore, not as accurate as the other values.

III. Results at Low Pressures

The clays were molded under the lowest pressure that would form the

stiffer mixes into a homogeneous cylinder. This proved to be 8 kilograms per square centimeter, which agrees well with the lower pressures used in forming clay. It was thought that a representative series of materials would include the following: (1) dry-milled quartz (potter's flint), (2) wet-milled quartz (168 hours in one gallon ball mill), (3) calcined English china clay, (4) English china clay, (5) red firing brick clay (Chelsea, Mass.), (6) dark English ball clay, and (7) bentonite.

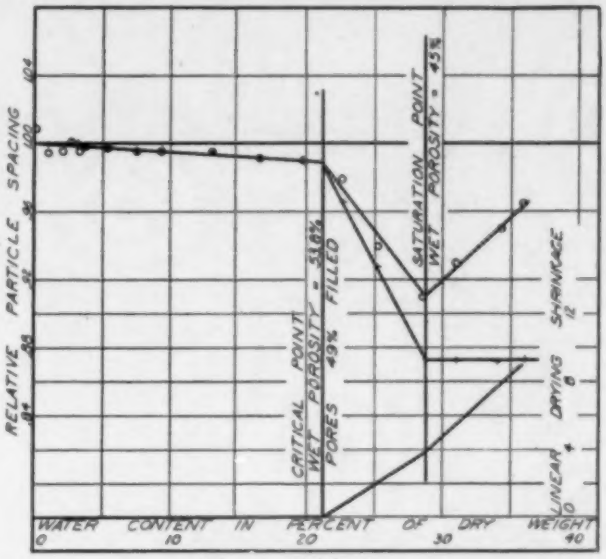

FIG. 5.—Brick clay.

It will be unnecessary to go into the detailed calculations. The general procedure will make the method clear. The density of the dry material with no load, after having been pressed under a load of 8 kilograms per

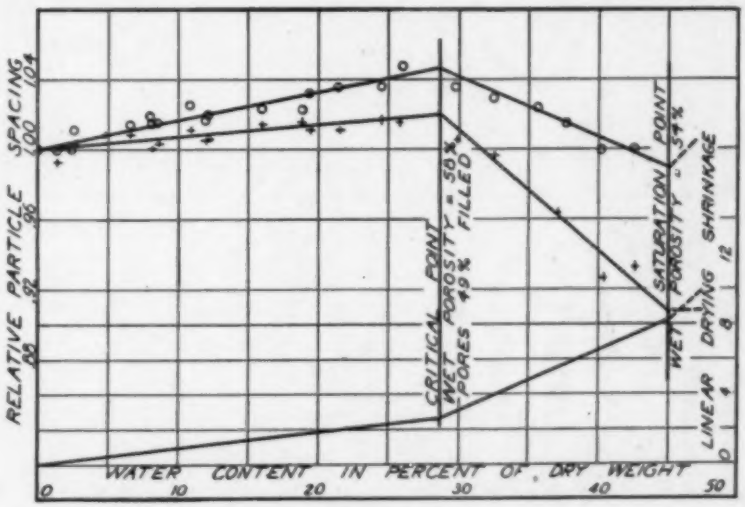

FIG. 6.—English ball clay.

square centimeter is considered to correspond with a particle spacing of 1.00. The spacing for other conditions is found by the following formula:

$$S_V = 100 \frac{d_1 - d}{d_1} \quad (1)$$

Where S_V = per cent change in volume based on the original size
d_1 = density under standard conditions
d = density under new conditions

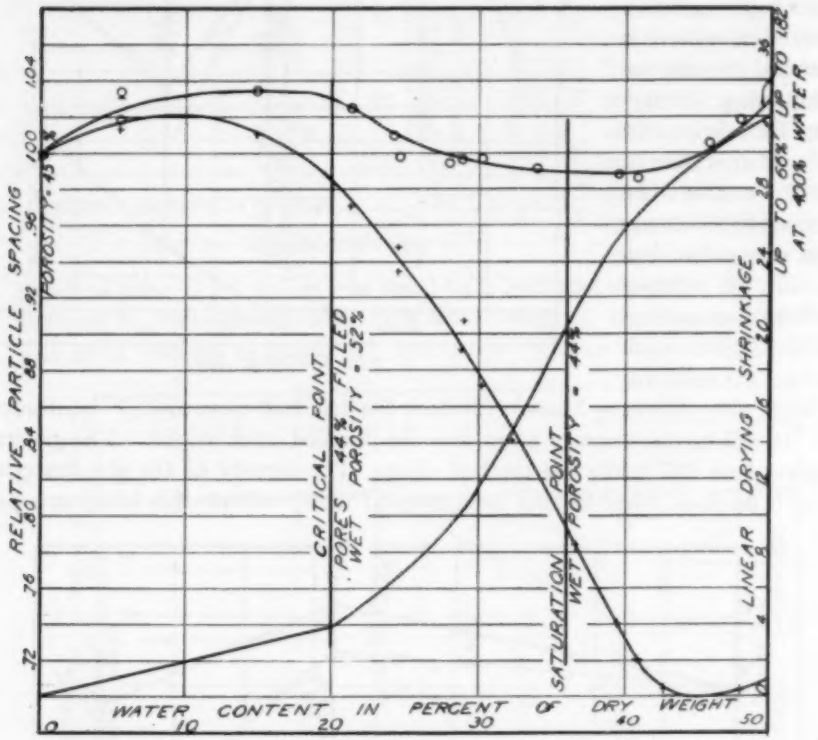

FIG. 7.—Bentonite.

S_V can be converted to linear change, S_L, or to particle spacing by the usual formula:

$$S_L = 100 \sqrt[3]{\frac{S_V}{100} - 1} + 1 \quad (2)$$

The drying shrinkage, in terms of the density under standard conditions (dry material at 8 kilograms per square centimeter pressure), is given by the difference between the spacing dry and the spacing wet.

The porosity is given by the following formula:

$$P = \frac{d' - d}{d'} \qquad (3)$$

Where d' = true specific gravity of clay
d = bulk density of clay

When the clay is wet, d is determined from the wet volume and dry weight.

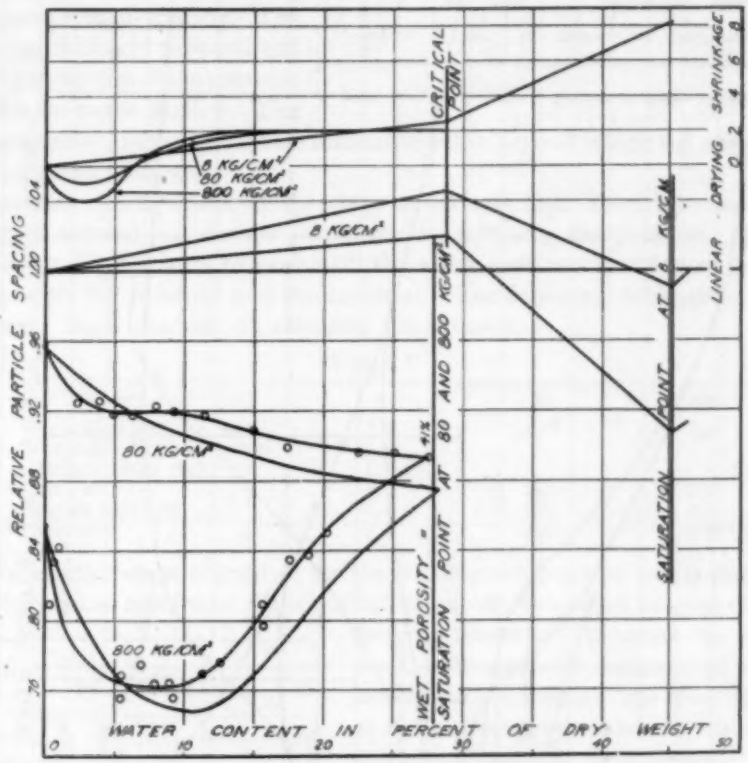

FIG. 8.—English ball clay at high pressure.

The values of d' were determined in the picnometer and in heavy liquids. A good agreement was obtained in all cases except for the bentonite, as no consistent values of the latter could be obtained in the picnometer. The values of d' for the various materials are as follows:

Quartz	2.65	Red firing brick clay	2.77
Calcined English china clay	2.48	English ball clay	2.56
English china clay	2.61	Bentonite	2.2

In Figs. 1 to 7 there are plotted the values of relative particle spacing and shrinkage for the various materials tested. The values of porosity

and the amount the pores are filled are indicated on the curves at the critical point and saturation point. The linear shrinkage is given by the difference between the wet and dry curves.

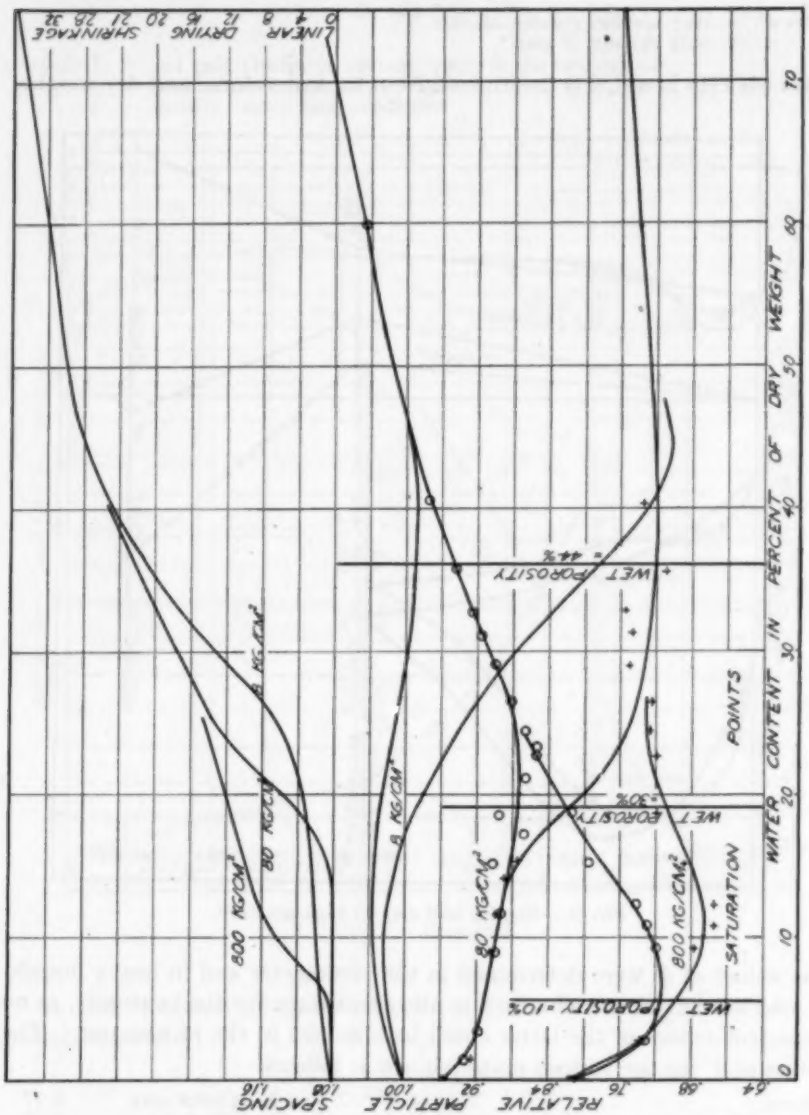
LINEAR DRYING SHRINKAGE
0 4 8 12 16 20 24 28 32
WATER CONTENT IN PERCENT OF DRY WEIGHT
0 10 20 30 40 50 60 70
RELATIVE PARTICLE SPACING
.64 .68 .76 .84 .92 1.00 1.08 1.16
WET POROSITY = 44%
WET POROSITY = 30%
WET POROSITY = 10%
8 KG/CM²
80 KG/CM²
800 KG/CM²
POINTS
SATURATION

FIG. 9.—Bentonite at high pressure.

IV. Results at High Pressures

In Fig. 8 the relative particle spacings are given for the English ball clay at 8, 80, and 800 kilograms per square centimeter. Similar curves were

obtained for the English china clay. The results for the bentonite are shown in Fig. 9, and curves for the dry-milled quartz are shown in Fig. 10.

Curves for the three clays tested are plotted in Fig. 11 to show the influence of pressure on the minimum spacing. The spacing is closely proportional to the logarithm of the pressure within the range studied. The spacing must, however, reach a minimum value beyond which the pressure has no great influence.

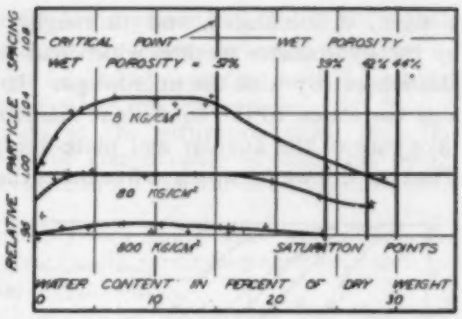

FIG. 10.—Dry-milled quartz at high pressure.

Another characteristic of the clays noted was their elasticity; that is, they all showed an increase in volume on releasing the pressure. This elasticity did not seem to vary with the water content; it did vary, however, with the pressure and the material. The following table gives the per cent linear increase on releasing the pressure.

TABLE I

Material	Pressure (kg./sq. cm.) 8	80	800
Dry-milled flint	1.4	3.5	1.6
Wet-milled flint	1.0		
Calcined china clay	1.5		
China clay	1.1	3.6	2.5
English ball clay	0.8	2.1	2.0
Bentonite	0.7	4.2	1.8

The elastic return is greatest for the 80-kilogram pressure and is similar for the various materials. It is difficult to explain this effect because of its large magnitude. It must be due mainly to the deformation of the loosely-packed grains. The low values at the highest pressure would indicate crushing of some of these grains.

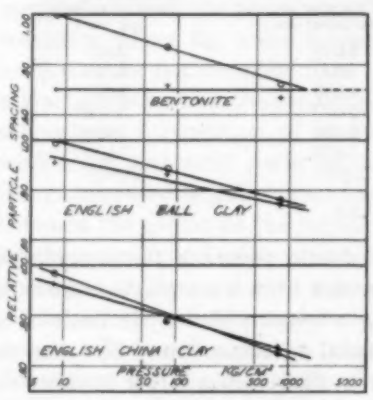

FIG. 11.—Effect of pressure on spacing.

V. Discussion of Results

In order to make the preceding data more logically connected, a grain-size analysis for all of the materials was made. This work was done by L. Jurgenson of the Soil Mechanics Laboratory at the Massachusetts Institute of Technology. The tests were carried out on samples soaked for

a week, deflocculated, and thoroughly agitated. Readings were taken by the hydrometer method which had recently been carefully checked in this laboratory with the microscope. It was necessary to add a considerable correction to the equivalent diameters determined by Stokes' law to take care of the angular and plate-like particles of the quartz and clay. The true size was as much as five times the equivalent size at true diameters of 0.00005 centimeter. This accounts for the small amount of colloids shown by these curves compared to that found by some other investigators. It is possible that the computed grain sizes for the clays are too large because of the enveloping film of water which may add to the apparent diameter. This error would, of course, increase rapidly as the grains become smaller. No careful calibration has been made with the microscope for the smaller clay particles. The size distribution is shown in Fig. 12. In the following table are given the computed average size of grains down to 0.00003 centimeter as well as the average surface for one gram of material. The comparatively great fineness of the wet-milled quartz is noteworthy.

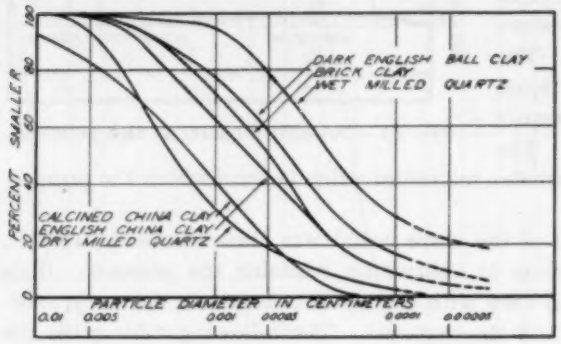

FIG. 12.—Particle size.

TABLE II

Material	Av. number of grains/linear cm.	Av. area for one gram of material (sq. cm.)
Dry-milled quartz	1400	2900
Wet-milled quartz	4000	9000
Calcined china clay	1100	2400
China clay	2400	5510
Brick clay	2600	5800
English ball clay	3400	7400
Bentonite*	20000	50000

* Estimated from rough microscopic observation.

Taken altogether, the preceding data should permit a fairly accurate picture of the nature of clay and its difference from a nonplastic material. There is always grave danger in forming a hypothesis on the basis of a limited amount of data in that a coincidental agreement may be taken as general. Therefore, until more data are available on a larger number of clays it will be safe only to form a picture on the basis of the more certain characteristics of the materials.

An examination of the data for the low pressure will clearly show that, in general, the following steps occur as the water content is increased:

(1) There is only a slight change in particle spacing until the critical point is reached, when there is a more or less sudden decrease.

(2) The minimum spacing occurs at the saturation point, but the material may, in some cases, be stable considerably beyond this point.

(3) At the critical point the pores are in all cases about 48% filled with water.

(4) The only distinct difference between the plastic and nonplastic materials is that the latter show practically no drying shrinkage and no large cohesion between the particles.

(5) The more plastic clays such as bentonite, English ball clay, and Kentucky ball clay (not shown) indicate a decided shrinkage below the critical point, while the others show none.

(6) The porosity in all cases is high (considering the graded sizing), except for the dried bentonite. This shows very close packing.

It is safe to say that the dry powdered clay, due to the rough and irregular particles, fails to pack closely, and that with the addition of water this packing may be slightly tighter or looser depending on whether the water film on the grains acts more as a lubricant or an adhesive. At the critical point, however, a sudden change occurs; the clay alters suddenly from a damp powder to a coherent, plastic mass, and the particles draw closer and closer together until the pores are filled. The nonplastic materials show similar curves, but the strong cohesion shown by the clay particles is absent.

The interpretation of the critical point is difficult. It might at first seem to represent the point where a certain thickness of water film is formed on the particles, but it will be seen that the area of the particles bears no relation to the water needed to reach the critical point. More significant is the fact that the critical point is reached in all the materials, plastic or nonplastic, when the pores are 48% filled. This amount can represent the condition where the water bridges between the particles have spread out until they form a complete film. Any increase beyond this will reduce the attraction at first on the smaller particles and allow them to re-orient themselves into a condition of closer packing. This re-orientation goes on with more and more particles until the pores are filled. In the case of clays this re-orientation is accompanied by a thickening of the water film between the grains as the capillary attraction is reduced. This seems to be the only logical explanation of the closer packing beyond the critical point and at the same time a greater shrinkage on drying.

The difference between plastic and nonplastic materials is seen to be very simple. It is not a matter of grain size or packing, but a property of the surface of the clay grains of attracting to itself a stable water film This is the force which holds the clay particles together, and not surface tension, for it is obvious that surface tension forces cannot act

when the pores are filled, and yet clay is quite cohesive under these conditions. If the surface tension is proportional to the length of air to water surface, then this force must increase from zero up to a maximum at the critical point, and then decrease to zero again at the saturation point.

It is not clear at present why the bentonite and the ball clays show some shrinkage below the critical point, while the leaner clays do not. Perhaps the more plastic clays have surfaces with a stronger attraction for water, so that a film is built up even before the capillary forces are broken down. Plasticity is probably influenced by two factors: grain size and activity of the grain surface.

Plasticity does not seem to bear any definite relation to grain size or to the water required to reach the critical or saturation point. Although in these tests the finer grained clays were the most plastic, this is not always true, and nonplastic materials may be finer than the clays.

Turning to the data for higher pressures, some interesting conclusions

TABLE III

Material	Max. thickness of water film (cm.)
Dry-milled quartz	0
Wet-milled quartz	0
Calcined china clay	0.1×10^{-5}
English china clay	2.1×10^{-5}
Brick clay	3.1×10^{-5}
English ball clay	2.4×10^{-5}
Bentonite	3.3×10^{-5}

can be reached. At the higher pressures the porosity is less, and the saturation point comes at lower water contents. In the case of clays, water seems to act as a lubricant and allows closer packing. At the highest pressures the clays show a minimum point at saturation. At the highest pressures more water than this allows the building up of intergranular water films having such great stability that they are quite unchanged as the pressure is increased from 80 to 800 kilograms per square centimeter at the point of their maximum thickness. Above the minimum, the drying shrinkage is practically unaffected by the molding pressure. This gives some idea of the magnitude of the attractive forces between the clay particle surface and water.

The bentonite is even more interesting. A minimum occurs at all pressures when the pores are filled. It will be noticed that the wet spacing curves are asymptotic to the same line; that is, the thickness of the water film at any given water content cannot be reduced below a certain minimum with pressure at least up to 800 kilograms per square centimeter. The minimum dried spacing is about the same for all pressures and the porosity reached is only 6%. This would indicate a close packing of a

plate-like material. It is difficult to see how evenly graded sizes of spheres or irregular particles could reach this low value.

The preceding picture of the clay structure can be made more definite by some actual dimensions. The size of the particles has been given, and the thickness of the water film can be readily computed from the shrinkage and the number of films in a given distance. In Table III are given the maximum film thickness for the various materials at a pressure of 8 kilo-

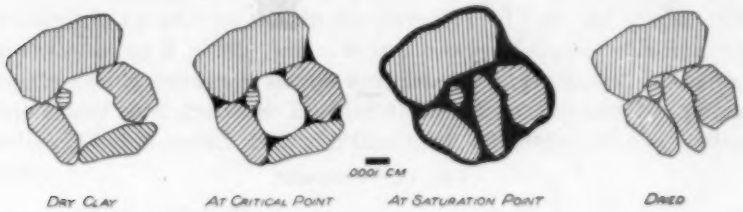

FIG. 13.—China clay.

grams per square centimeter, assuming that every particle has a film on it. The actual value may be slightly larger than this because the films on some of the small particles do not influence the total shrinkage.

It is remarkable that the film is so nearly of the same thickness for all of the plastic materials. The film on the nonplastic materials is absent, for the slight shrinkage of the calcined china clay is probably due to the beginning of rehydration.

In order to make the clay structure clearer there are shown in Figs. 13

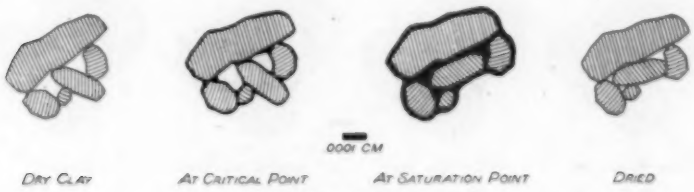

FIG. 14.—Ball clay.

to 16 a number of sections of clay drawn to scale. Figure 13 shows the china clay under various conditions. The ball clay is represented to the same scale in Fig. 14. It will be noted that the intergrain water films have developed even at the critical point. Figure 15 shows a probable structure of bentonite to the same scale. A nonplastic such as the dry-milled quartz is shown in Fig. 16.

There now seems to be ample proof that clays show plasticity because of a strongly attracted water film around each grain. It is not known whether all grains have this activated surface, or just the smaller ones,

but the close agreement in film thickness for the different clays would at least indicate that all the surfaces were active (in a pure clay). Again, it is not known whether this activated surface is the same for all clays. Perhaps the more plastic clays have a more strongly attracting surface than the lean ones. This seems to be borne out by the fact that the ball clays form a water film below the critical point, and the lean clays do

FIG. 15.—Bentonite.

not. The aging of clays also develops plasticity, which means that the surface film is more strongly attracted after long contact with water.

To make complete the picture of the clay structure it will be necessary to know the cause and nature of the activated surface. Unfortunately, only speculations can be made on it at present. A few facts, however, are available which throw some light on the subject. In the first place, the clay grain must be composed of a hydrated aluminum silicate and it must be wet with water. The clay-like properties are developed by slow processes of hydration in the ground, or even in the laboratory to some ex-

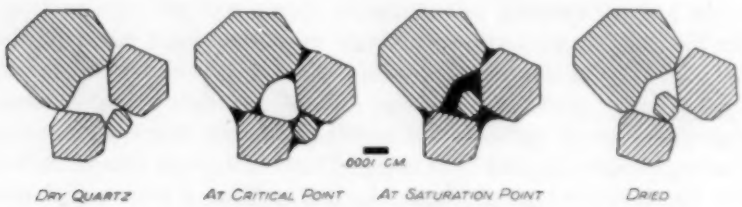

FIG. 16.—Dry-milled quartz.

tent. Some believe that the effect is a simple chemical combination with water, perhaps according to the hexite-pentite theory of the Asch's. Others believe it to be due to the formation of a colloidal layer over the particle surface.

It is true that most, if not all, clays contain detached colloidal particles, but it is not proved that they are necessary to plasticity. In this connection a comparison of the raw and calcined china clay is interesting. Calcination destroys the plasticity, and at the same time joins many of the small particles so that the effective grain size is practically doubled.

Two weeks' aging, however, in water nearly restored the original plasticity, and the shrinkage was almost as high as originally.

VI. Summary

It may be concluded that clay is composed of hydrated aluminum silicate particles of varying degrees of fineness which have the characteristic of attracting to their surface with great force a film of water which is mutual with the adjoining particle; this provides both the cohesion and lubrication existing in a plastic mass. In the clays studied here, the maximum film thickness is about 3×10^{-5} cm. It is the evaporation of this film which causes the drying shrinkage always associated with plasticity. Nonplastic materials may have the same fineness as clay, but they lack the power of attracting a stable surface film, and thus have little cohesion and no drying shrinkage.

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COLOR FORMATION IN VITREOUS BODIES[1]

By F. H. Norton and V. J. Duplin, Jr.

ABSTRACT

A simple vitreous body of the Parian type was made up and the coloring produced by adding varying amounts of cobalt, chromium, iron, uranium, nickel, and copper oxide was determined. The color was measured by the Hardy recording spectrophotometer, and the resulting curves were analyzed for the three attributes of color. The hue, brilliancy, and saturation were all proportional to the logarithm of the coloring oxide. It was found that the color was mainly due to the particles of the practically undissolved oxide, and not to a colored glass. This makes it possible to color a body for use in reflected light, but not for transmitted light. Some excellent magenta red bodies were produced by reducing the copper oxide, but the results could not be consistently reproduced.

I. Introduction

Use has been made of colored bodies to a considerable extent in artistic pottery; notable examples are the jasper bodies of Wedgwood and the colored pastes used at Sèvres, but as far as it is known no systematic work has been undertaken to study the mechanism of the color formation in bodies of this type. It is for this reason that the present work has been undertaken. A good deal of assistance has been obtained from the previous work on the color formation in lead glazes by D. T. H. Shaw,[2] but the present problem is more simple in that there is little chance for the composition of the body changing during the firing period as always occurs in the glaze due to the absorption of silica from the body and volatilization of the lead. The bodies differ from the glazes also in that only a small amount of glass is formed in the bodies and this glass is very viscous, having, therefore, a low dissolving power for the coloring oxide as compared with the more fluid and completely formed glass in the lead glazes.

II. Experimental Procedure

A typical Parian body was made up containing the following materials: quartz-free potash feldspar 60%, English china clay 30%, and English ball clay 10%. Expressed in molecular form this body is $0.41\ RO : Al_2O_3 : 3.64\ SiO_2$.

A mix was made up according to this formula to form the white member of each colored series. The strongest colored member of each series was made up in such a way as to have the same maturing temperature as the white body. This was accomplished with a few trials in the following way:

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[1] Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (White Wares Division). Received December 9, 1931.

[2] "Color Formation in Raw Lead Glazes," *Jour. Amer. Ceram. Soc.*, **15** [1], 37 (1932).

One-half of the alkali or 0.2 K_2O was replaced by 0.4 equivalent of the coloring oxide. This is expressed in the case of iron by the following formula:

$$0.21\ K_2O$$
$$0.40\ FeO : Al_2O_3 : 3.64\ SiO_2$$

This gave a very strongly colored body with approximately the same maturing temperature as the white body. After the bodies had been made up in slip form, blunged, and screened, they were dried and the white body blended with the colored body in various proportions to give the desired concentration of coloring oxide. This dried mixture was then made up in the form of a slip and thoroughly blunged.

The oxide was not added directly to the body, but was mixed with a portion of the feldspar and sintered at 2000°F. The resulting product was then ball-milled with the rest of the ingredients for 20 hours.

The following oxides were used as they represented the elements most likely to give colors at the comparatively high temperature required for a vitreous body: Fe_2O_3, Cr_2O_3, Co_3O_4, CuO, NiO, and Na_2UO_4.

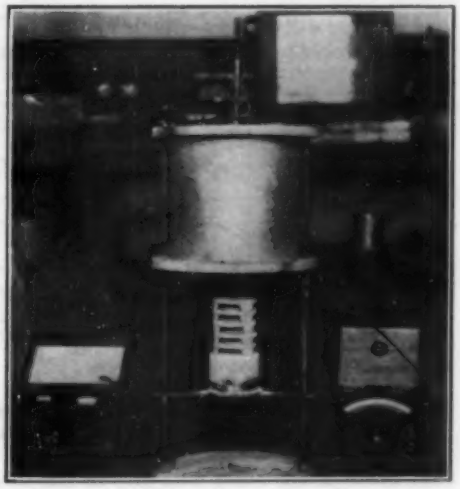

FIG. 1.

The specimens themselves were made in the form of disks about $1\frac{1}{2}$ inch in diameter and $\frac{1}{8}$ inch thick. A number of brass rings cut from thin tubing were laid on the top of a clean plaster block and the slip was poured into them. As soon as the specimens were stiff enough the brass rings were removed and they were turned over to dry which prevented any appreciable warping. Before firing, the finished surface of the specimen was carefully smoothed off with fine sandpaper to give a uniform surface, and a reference number was scratched on the back.

The specimens were all fired in a special electric furnace with silicon-carbide resistors. This furnace was convenient as it gave a clean oxidizing atmosphere and permitted accurate temperature control by means of a platinum couple and a recording potentiometer. The furnace is shown in Fig. 1.

All of the specimens were fired on the same schedule, that is, brought up to the temperature of 2115°F in one and one-half hours, and held at that temperature for one-half hour.

Some experiments were made with the copper specimens in neutral and reducing atmospheres. In a number of cases beautiful magenta reds were produced, but the color could not be closely controlled so that the actual colorimetric results are not included here. This, however, will form the subject of future investigations.

III. Color Analysis

The color of each sample was determined on the Hardy recording spectrophotometer, which plots a curve of wave-length against reflecting power directly. A typical set of curves for the chromium bodies is shown in Fig. 2. Each of these curves was analyzed in order to express the color in its three attributes: brilliancy, hue, and saturation. This analysis is rather involved, but the reference[3] given below should be consulted as to the details of this computation.

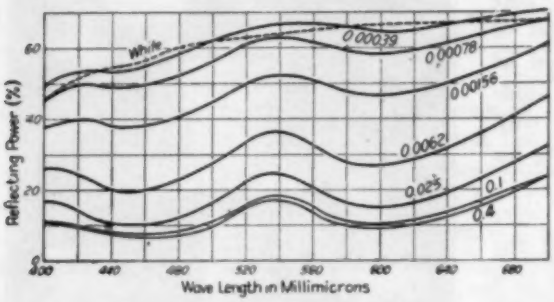

FIG. 2.—Photometric curves for Cr_2O_3 specimens. The figures represent the equivalent of Cr_2O_3.

IV. Results

Thin sections were made of a number of the specimens in order to determine as far as possible the actual condition of the coloring material in the body. It had previously been supposed that most of the color was due to the solution of the coloring oxide in the glass which is formed in a vitreous body. The miscroscopic examination, however, showed that the color occurred in widely scattered but definite spots which were probably the oxide particles practically undissolved, retaining their original shape and color. This is confirmed by the fact that the thin sections showed no color by transmitted light, but showed a characteristic color by reflected light. In the case of cobalt, slight solution of the grains was evidenced by a slight bluish halo around them, and this might be expected from the strong coloring power of this oxide. Even in this case, however, the solution was slight. One of the cobalt specimens was heated for an hour at 2600°F which practically fused the body. After this treatment it was noted that the color had become somewhat lighter and a microscopic examination showed almost complete solution of the cobalt oxide. This body was very much overfired, a condition which would never occur with correct firing.

In Table I the color attributes of the various specimens tested are given.

[3] *Jour. Opt. Soc. Amer. and Rev. of Sci. Instruments*, **6**, 330 (1922).

It should be realized that the saturation values for the more concentrated colors are not obtained with great precision.

TABLE I

Equivalents of Oxide		Hue	Saturation	Brilliance	Color
0.4	Fe_2O_3	601	34.0	7.4	Maroon
0.2		597	36.0	8.3	"
0.1		597	22.0	12.9	Reddish brown
0.05		590	19.0	24.0	Light brown
0.025		590	13.0	35.0	" "
0.0125		588	11.0	40.0	Cream
0.0031		585	11.0	65.0	"
0.0015		585	10.5	65.0	"
0.2	CuO	582	29.0	11.4	Dark gray-green
0.1		578	29.0	23.0	Gray-green
0.05		577	26.0	32.0	" "
0.0125		577	20.0	49.0	Cream
0.4	Cr_2O_3	567	36.0	13.7	Bright chrome green
0.1		566	36.0	13.3	" " "
0.025		566	36.0	19.0	" " "
0.0062		568	27.0	31.0	Light green
0.0016		574	17.5	49.0	" "
0.00078		575	14.5	60.0	" "
0.00039		575	14.5	65.0	Cream
0.00020		580	14.0	65.0	"
0.2	NiO	578	22.0	9.9	Brown
0.05		582	22.0	13.1	"
0.0125		582	21.0	30.0	Light brown
0.0031		585	15.5	48.0	" "
0.4	Co_3O_4	472	22.0	2.8	Deep blue
0.1		473	20.0	4.5	" "
0.025		474	19.0	8.1	" "
0.0062		476	7.0	26.0	Blue
0.00156		480	1.5	44.0	Pale blue
0.00078		570	2.5	58.0	" "
0.00039		580	5.0	62.0	" "
0.00020		580	7.5	65.0	Cream
0.4	Na_2UO_4	575	5.5	6.0	Black
0.1		600	1.0	6.2	"
0.025		600	2.0	18.1	Dark gray
0.0062		580	7.0	43.0	Light gray
Body		580	12.0	65.0	Light cream

In Fig. 3, the values of brilliance are plotted against the logarithm of concentration for the various specimens. It is interesting to observe that the brilliance may be expressed by a straight line, and that this line has the same slope for all of the elements tested.

If B = brilliance at concentration C
B_0 = brilliance at zero concentration (white body)
C_0 = minimum concentration affecting brilliance
k = slope of curve
Then $B = B_0 - k(\log C - \log C_0)$

The value of the brilliance diminishing power, k, is constant for all of the oxides tested within the experimental error. This value is 28.

The values of C_0 are as follows:

	Equivalent		Equivalent
Cu	0.0033	Ni	0.0008
Fe	0.0020	Cr	0.0005
Ur	0.0009	Co	0.0003

Another interesting feature of these curves is that above a certain concentration there is no change in brilliance. This fact may be explained by considering that for a certain concentration enough particles of oxide are present in the translucent body to cover the area completely, and that additional particles will have no effect. At the lower end of the curves it will be seen that a certain concentration is necessary before any change in brilliance can be observed. The stronger the coloring power of the oxide, the lower the concentration needed to effect this change.

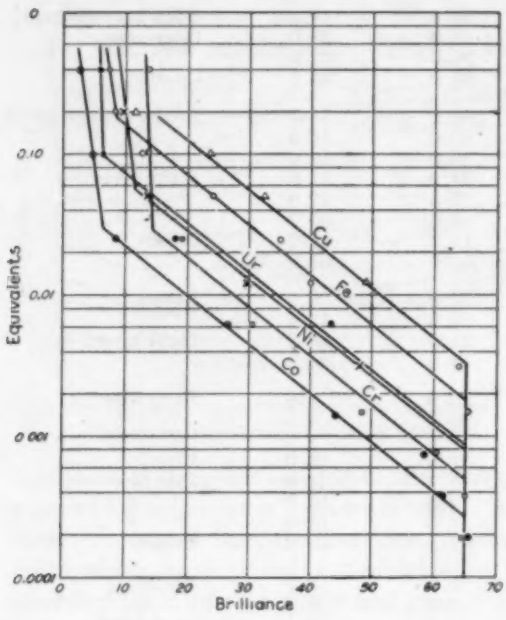

FIG. 3.

The influence of concentration on hue is shown in Fig. 4, where the dominant wave-length is plotted against the logarithm of the concentration. It will be seen that copper, uranium, and nickel have approximately the same hue as the body itself, and the dominant wave-length is not affected by the concentration. On the other hand, the iron produces a higher dominant wave-length, and this approaches that of the body as the concentration is decreased. The same is true for the chromium except that this is in the green region. The cobalt has a very low dominant wave-length and shows an interesting characteristic in that the color is complementary to the yellowish tinge of the body itself so that at a certain concentration one color neutralizes the other, and a discontinuity in the curve is obtained, which represents the whitest combination. Cobalt is commonly used to neutralize the yellowish tinge in bodies, and it is interesting

to see how accurately data of this nature are able to give the exact concentration of cobalt oxide needed to neutralize the color of the body.

In the same way as for brilliance, hue may be expressed by the following formula:

$$H = H_0 + k \log C$$

Where H_0 = hue of white body
C = concentration of coloring oxide
k = slope of line

It will be noted that k is negative for oxides having a dominant wave-length above that of the body itself, while those having a lower dominant wave-length have positive values. This is in agreement with the results obtained by Dr. Shaw in the lead glazes.

The saturation values are plotted in Fig. 5 against logarithm of concentration. It will be noted that at the upper end of the curves a break was obtained in the same way as for the brilliancy curves, which indicates that the whole area is covered by the oxide particles at a certain concentration. The lower ends of the curves approach the saturation for the white bodies, which in this case is 12%. The curve for the cobalt is interesting in that the saturation goes down to zero at the point where the blue of the cobalt just intersects the yellow of the body itself. The results for uranium show low saturation values, but the precision in this range is not great. The saturation may be expressed by the following formula:

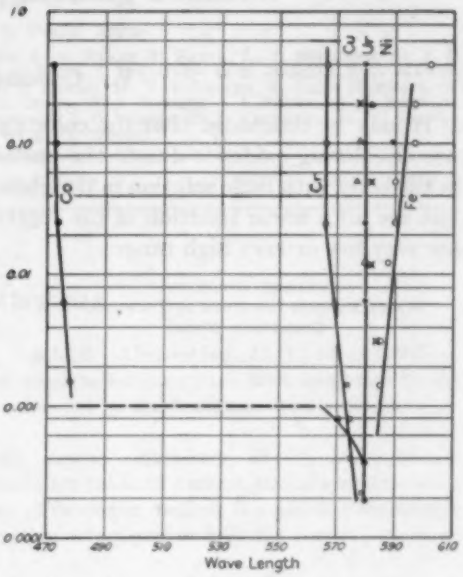

FIG. 4.

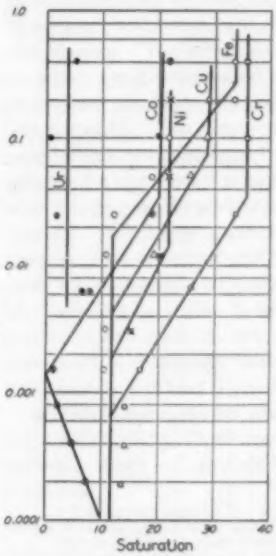

FIG. 5.

$$S = S_0 + k (\log C + \log C_0)$$

Where S_0 = saturation of white body
C = concentration of coloring oxide
C_0 = concentration first influencing saturation

The value of k for all of the oxides is 14, while the value of C_0 is as follows:

	Equivalents
Cr	0.0006
Ni	0.0020
Cu	0.0040
Co	0.009
Fe	0.017

V. Conclusion

It may be concluded that the color produced in vitreous bodies by the use of coloring oxides is due to the particles of oxide which are embedded in the body with little solution in the glass. The saturation, brilliance, and hue are all a linear function of the logarithm of the concentration, except for very low or very high ranges.

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CERAMIC ABSTRACTS[1]

Compiled by the

AMERICAN CERAMIC SOCIETY

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Vol. 11 **March, 1932** **No. 3**

Abrasives

Proposed standard finish symbols. A.S.M.E. *Abrasive Ind.*, **13** [1], 13–14 (1932).—Standards for the quality of finishes of machine surfaces have been sponsored by the A.S.M.E. and their initiation has been approved by the American Standa.ds Assn. E.P.R.

Carborundum finishing compounds. Anon. *Machinery*, **35** [7], 543 (1929).—Abrasives for lapping and finishing metals are made in varicus grades and accurately graded to size by the Carborundum Co. The carrier medium is a special noncorrosive composition designed to allow quick cutting action and to hold the abrasive grains in suspension under all conditions. W.C.O.W.

Steel mill roll finishing. II. H. J. Wills. *Abrasive Ind.*, **12** [12], 16–17 (1931).—The stresses set up at the grinding face by the wheel rotation and work pressures are close to ultimate impact resistance of the bond and grain structure. A slight increase of pressure will break or dislodge the grains and a decrease will cause dulling of crystals and glazing. The relation of wheel speed to work speed will determine shearing force. As wheel speed is increased in ratio to work speed, the stresses set up between work and wheel face are lessened, and the wheel is not broken down as rapidly as under lower wheel speeds. The degree to which wheel action is affected depends on the characteristics of the abrasive wheel used. Wheel and work speeds should be adjusted to compensate for the variation in stresses due to the reduction of wheel diameter. (1) Rigid, nonvibrating machine elements permit the use of softer wheels with resultant production increase. (2) Large diameter rolls permit softer bonds owing to the greater area of contact between wheel and work. (3) For chilled iron rolls, silicon carbide wheels are used for roughing and finishing; for hardened steel rolls, alumina wheels are used. (4) Finishing cuts may be improved with narrow wheels. To avoid changing wheels it is practical to dress the wheel face to the desired width. Dressing for roughing cuts is done most economically with the conventional dresser. For finishing cuts a diamond is necessary. For Part I see *Ceram Abs.*, **11** [1], 2 (1932). E.P.R.

Abrasive products for glass, pottery, and enamel. H. A. Plusch. *Ceram. Ind.*, **18** [1], 25–27 (1932).—The two general types of abrasives are aluminum oxide and silicon carbide. Both are electric-furnace products. Aluminum oxide is the most efficient

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

abrasive for cutting steel and materials possessing high tensile strength. Silicon carbide is sharper and more brittle and is the best abrasive for grinding materials of low tensile strength such as cast iron, bronze, brass, aluminum, slate, marble, glass, etc. Bonding materials, grain size of abrasive, and shape of grinding wheels are discussed. A soft-grade wheel has a weak bond; a hard-grade wheel has a strong bond between abrasive grains. Ceramic industries using grinding wheels are listed and some of the uses described, especially the grinding of enamelware and the uses of grinding wheels in the glass industry. Each grinding operation requires a special combination of type of abrasive, right bond, and right grain size. W.W.M.

Adhesion of glue and fused alumina abrasives. III. HENRY R. POWER. *Metal Cleaning & Finishing*, **3** [12], 989 (1931).—The developments in abrasives that have been rapidly advancing in recent years and have brought out treated products with a specific surface adhesion for glue, known as surface tenacity abrasives, have made it possible to use a lower quality glue with no loss of adhesion value in some polishing operations. For Part II see *Ceram. Abs.*, **10** [11], 745 (1931). E.J.V.

Correct cutting action in surface grinding. ANON. *Abrasive Ind.*, **13** [1], 15–16 (1932).—Plane surface grinding differs from cylindrical grinding in the positioning of the work and the wheel. The area of contact is greater and the rate of movement of the work in respect to the wheel is different. The work speed of traverse of ordinary surface grinding machines cannot be increased to change the wheel-cutting action. Wheel speed is the only adjustable factor. E.P.R.

Cylindrical grinding vs. accuracy. FRED B. JACOBS. *Abrasive Ind.*, **13** [1], 12–13 (1932).—Accuracy is a relative term inasmuch as no part can be fabricated more accurately than the gages used to test it. To finish parts within close limits, substantial grinding machines must be employed to insure maximum production. E.P.R.

Grinding methods for motor rims. FIRESTONE STEEL PRODUCTS CO. *Abrasive Ind.*, **13** [1], 9–11 (1932).—Rubber-bonded wheels 14 to 18 in. in diameter are used at a peripheral speed of 8000 ft. per min. for grinding the outside of the welds. Somewhat smaller sizes are used for the inside work on the rims. E.P.R.

Conservation of grinding wheels. E. H. FISH. *Abrasive Ind.*, **13** [1], 14 (1932).—A grinding wheel may be sharpened by a dresser which loosens the bond so that the dull particles fall off. Abrasive wheelmaking is described. E.P.R.

Use of diamonds. ANON. *Abrasive Ind.*, **13** [1], 28 (1932).—An even, steady pressure will not harm a diamond, but sharp blows will split it and overheating will wear it rapidly. Reset diamonds will cut just as well as new ones. E.P.R.

Dust hazard in the abrasive industry. W. I. CLARK. *Jour. Ind. Hyg.*, **13** [10], 343–46 (1931).—A study was made of the amount of pulmonary tuberculosis occurring during the past 13 years in the plant of a grinding-wheel company where workers were exposed to silicon carbide and alumina dust. Data comparing the extent of tuberculosis in the plant with that in the city as a whole were not conclusive. It was concluded that it is inadvisable for persons who have had pulmonary tuberculosis to work where large amounts of artificial abrasive or any other dust are present. H.F.V.

BOOKLET AND BULLETIN

Abrasive materials in 1930. PAUL HATMAKER AND A. E. DAVIS. Bur. Mines, *Mineral Resources U. S.*, 19 pp. 5¢. R.A.H.

Aloxite TP Manual of Modern Polishing Practice. CARBORUNDUM CO. Reviewed in *Abrasive Ind.*, **13** [1], 32 (1932).—This 24-page, illustrated booklet describes modern polishing problems. See also *Ceram. Abs.*, **11** [2], 69 (1932). E.P.R.

PATENTS

Work-supporting mechanism for grinding machines. HERBERT A. SILVEN AND

ALBERT G. BELDEN. U. S. 1,837,342, Dec. 22, 1931. A work-supporting and rotating mechanism for a grinding machine comprising a rotatable spindle, a work-supporting and clamping device mounted on the spindle, means including a clutch to rotate the spindle, means including a fluid-pressure device arranged to operate the clamping device, and a manually operable lever arranged to operate the clutch when moved in one direction and to control the fluid-pressure device when moved in another direction.

Centerless grinding machine. HAROLD W. HOLMES. U. S. 1,837,821, Dec. 22, 1931. A grinding wheel adapted to be rotated at a relatively high speed, a regulating wheel adapted to be rotated at a relatively low speed, means for holding between the wheels and in operative relation thereto a succession of thin cylindrical work pieces positioned face to face, the path of travel of the face of the regulating wheel being inclined with respect to the axis of the work to exert an axial feeding component upon the work, and means adapted to bear yieldingly in an axial direction against the work pieces to hold their adjacent end faces in contact whereby the work pieces tend to support each other against twisting.

Grinding machine. THOMAS CORNELIUS SHEEHAN. U. S. 1,838,196, Dec. 29, 1931. A machine for grinding oval knife bolsters comprising mechanism for rigidly holding and producing a parallel flying movement of the bolster that is the resultant of a rotating movement on its own axis and an orbital movement about a parallel axis, grinders selectively operative in stationary position at different sides of the bolster, and means for selectively timing the flying movement to keep the bolster in contact with the selected grinder.

Knockdown mold. EDWARD ANDERSON. U. S. 1,838,518, Dec. 29, 1931. A mold for grinding wheels comprising a bottom plate adapted to form one side of a wheel, a ring resting on the plate to form the periphery of a wheel, the ring being formed of segments and tapered toward the plate, a jacket surrounding the ring and tapered interiorly in conformity to the exterior of the ring, and supporting blocks for the jacket adapted to lie on a plane surface on which the bottom plate lies and support the jacket at an altitude enabling the jacket to hold the segments in the form of a ring, the blocks being removable when it is desired to let the jacket down to release the segments.

Mutual counterbalancing of tool holders of grinding machines. LEO SICHEL. U. S. 1,839,002, Dec. 29, 1931. A device comprising a column vertically supported on a base, a pair of arm sections slidably mounted on the column, tool heads supported on the arm sections, and a means for counterbalancing one of the arm sections against the other.

Grinding mechanism. CHARLES J. OLOFSON. U. S. 1,839,253, Jan. 5, 1932. Grinding mechanism comprising, in combination, a tapered shank member provided with a head, a peripheral groove extending about the base of the head, a retainer collar secured to the head and forming a channel about the peripheral wall thereof, collector rings rotatably journaled within the channel and insulated from the shank head, electrical brushes secured to the bottom of the head and extending radially thereof to contact the collector rings, a cup-shaped motor carrier secured below the shank, means for moving the carrier across the bottom face thereof and securing it in adjusted position, a motor carrier within the carrier having an armature shaft depending centrally thereof, means for supplying current to the collector rings, and means whereby the current is transmitted through the brushes to the motor.

Expanding device for grinding tool. THOMAS F. QUIGLEY. U. S. 1,839,261, Jan. 5, 1932. Transmission means suitable for use in applying power to an expansible tool and also to an expanding device therefor, the means comprising, in combination, a main carrier member, planetary gearing mounted in the carrier member, a ring gear, motion-transmitting means movable by the ring which are positioned in the carrier

member and connected with the planetary gearing, and means movable differentially by respective gears of the planetary gearing to cause effective action of the expanding instrumentalities.

Work head for grinding machines. GEORGE H. P. GANNON. U. S. 1,839,546, Jan. 5, 1932. In a machine, the combination with a headstock mounted for slidable motion on a machine frame, of a spindle journaled in the headstock, and a cam journaled in the headstock independent of the spindle, the spindle and the cam being coaxial and connected severally to a common driving means whereby the spindle and cam are rotated simultaneously.

Precision grinder. FRED H. WHITMAN. U. S. 1,839,627, Jan. 5, 1932. In a precision grinder, a grinding element, means for rotating the grinding element, a work holder, means for feeding the work holder longitudinally of the grinding element, and means for reciprocating the work holder transversely of the grinding element, the last-mentioned means comprising a cable secured to the work holder, rollers supporting the cable, and devices for moving the cable to and fro on the rollers.

Grinding fixture. EDMUND A. SPRUNG. U. S. 1,839,810, Jan. 5, 1932. The combination with a grinding wheel of a vertically extending post adjustably secured in spaced relation thereto, a grooved block mounted to swivel and rotate on the post, adjustable work-retaining members on the block adapted to engage the stem of a valve to secure the latter thereon, a goose-neck rod adjustably secured to the bottom of the block to extend outwardly beyond the head of the valve, a sleeve slidably mounted on a portion of the rod that is bent back toward the valve head, and a spring surrounding a portion of the rod and engaging the sleeve in a manner to force it into contact with the valve head.

Grinding machine. WARREN F. FRASER. U. S. 1,840,088, Jan. 5, 1932. A grinding machine comprising a grinding element, a carriage for supporting a work piece having a series of spaced blanks therein, fluid-pressure mechanism including a piston operatively connected to the carriage, valve means for admitting fluid under pressure to one side of the piston for moving the carriage to present successive blanks to the grinding element, a valve-control device including dogs on the carriage connected to operate the valve to stop the carriage, and a mechanism connected to move the valve after a predetermined time interval to start the carriage.

Grinding machine. ROBERT E. W. HARRISON AND FRED S. HAAS. U. S. 1,840,231, Jan. 5, 1932. A machine including a work support and a grinding wheel, means for automatically varying the relationship of the parts during grinding to control the shape produced on a work piece by the grinding wheel, means for relatively shifting the parts in an angularly related direction to vary the general area of the work engaged by the grinding wheel, and means for automatically stopping all relative movement of the parts when a series of sequential grinding operations on a plurality of axially displaced portions of the work has been completed.

Truing and dressing grinding wheels. FERDINAND J. HOHNHORST AND FERDINAND J. KROEGER. U. S. 1,840,718, Jan. 12, 1932. In mechanism for truing and dressing composite grinding wheels, the combination with the grinding wheel of a composite abrading bar having a texture harder and coarser than the texture of the grinding wheel, means for pivotally supporting the abrading bar for presenting its end to the grinding wheel, the presented end being of arcuate form, and means to oscillate the abrading bar on its pivot for moving the arcuate end of the abrading tool across the grinding wheel while in contact with the grinding wheel and causing it to traverse the grinding surface of the grinding wheel in opposite directions in arcuate paths to thereby clean and sharpen the grinding surface.

Grinding cylindrical surfaces. MARSDEN C. HUTTO. U. S. 1,840,720, Jan. 12,

1932. A grinder for cylindrical surfaces comprising a rotatable supporting body, means for mounting abrasive members on the body for grinding either external or internal cylindrical surfaces including outer and inner radial guideways formed on the outer and inner parts of the body, stone holders adapted to be slid in the guideways toward and from the axis of the tool, and adjusting means mounted on the body between the outer and inner guideways and adapted to shift the stone holders radially.

Work-handling mechanism for grinding machines, etc. CARLE J. EIGHBERG. U. S. 1,840,841, Jan. 12, 1932. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between the grinding instrumentality and the chuck, including means for causing a substantial separation between the instrumentality and chuck followed by a return motion to bring the parts together again for further relative reciprocatory motion, of means for determining when a work piece has been ground to the desired size, a work carrier, and means set in operation by the last-named means and brought into operation during the movement of separation for causing the work carrier to move into engagement with the work in the chuck, disengage the work from the chuck, and move out of the way of the grinding instrumentality.

Cutter grinding machine. JOSEPH GSTYR. U. S. 1,841,244, Jan. 12, 1932. In a grinding machine, a work support, a grinding member, means for producing a relative movement between the grinding member and the work support to effect the grinding operation, fluid-pressure operated means for dressing the grinding member, fluid-pressure operated means for feeding the dressing means relative to the grinding member, and means controlling the operation of each of the fluid-pressure operated means to actuate each periodically at predetermined intervals in the operation of the machine.

Abrasive reamer. CLARENCE W. TYDEMAN. U. S. 1,841,343, Jan. 12, 1932. In a device, the combination with a two-part adjustable cylindrical body portion, of means carried intermediate of the parts for expanding or contracting them to various predetermined diametrical sizes, the parts being biased toward minimum diameter position by means of a spring, means comprising a sleeve slidably connected to the device for moving the parts against the spring and toward maximum diameter position, and an adjustable stop for limiting the movement of the sleeve in a direction to increase the diameter.

Cylinder honing devices. J. SUNNEN. Brit. 362,015, Dec. 9, 1931.

Machines for grinding ball races. LANDIS TOOL CO. Brit. 362,349, Dec. 16, 1931.

Grinding, surfacing, etc., machine tools. LUMSDEN MACHINE CO., LTD., E. G. BLAKE, W. S. LUMSDEN, AND J. H. STANIER. Brit. 362,750, Dec. 16, 1931.

Hydraulically operated cylindrical grinding machine. NORTON CO. Brit. 363,020, Dec. 23, 1931.

Grinding or abrading machines. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 363,023, Dec. 23, 1931.

Tools for dressing grindstones in wood grinders. A. ELSENHANS. Brit. 363,119, Dec. 23, 1931.

Grinding, polishing, and rotary cutting or turning machines. J. A. MOORE. Brit. 363,608, Dec. 30, 1931.

Art and Archaeology

Metallic constituents of gold for gilding in ceramics. I. Refractory metals. A. NAKATSUCHI. *Jour. Soc. Chem. Ind.* [Japan], **34** [5], 164–65*B* (1931); *Chim. & ind.*, **26** [5], 1129 (1931).—When heating to 500° a ceramic object covered with a thin coat of a compound of gold with a terpenic sulphide (called balsamic gold), a beautiful luster is obtained, but the thermal resistance decreases and metallic grains appear on the gilded coat. An addition of metal to the gilding eliminates this defect even when

heated up to 768°C. Rhodium has the highest preventive action; aluminum, thorium, and tin can be used up to 700°; iron, chromium, antimony, ruthenium, nickel, cobalt, and iridium, to 650°; alkaline metals, strontium, barium, lead, cadmium, uranium, silver, manganese, palladium, and platinum increase the thermal resistance slightly; and zinc, magnesium, bismuth, copper, and calcium have no action. It is peculiar that metals having analogous properties behave differently in this case. N. assumes that the refractory metals are a "colloid protection" for the gold. Rhodium was the most studied and researches were made on a gilding containing some bismuth and chromium besides iron and rhodium. It was found that (1) even with the maximum rhodium content, a small addition of bismuth or chromium suffices to produce metallic grains and to dull the metallic surface; (2) rhodium may be added to the gilding in the form of resinate or a compound of balsamic sulphide; (3) rhodium changes into rhodium oxide after heating to 768°. **II. Stabilizing action of bismuth.** *Jour. Soc. Chem. Ind.* [Japan], **34** [5], 165–66*B* (1931); *Chim. & ind.*, **26** [5], 1129 (1931).—During the studies of the stabilizing action of bismuth in ceramic gilding, N. found that when the gilding is contained in small quantities in the resinate of bismuth and the quantity of gold is not over 2.95% of the metallic total, gold is dispersed in colloidal form in the melted mixture of the glaze and Bi_2O_3 and produces a pink coloration. If the quantity of gold is larger, a great quantity of metallic grains appears on the fine coat of the gilding and the pink coloration deepens. In the presence of other metals resistant to heat, *e.g.*, rhodium, the grains are not formed and the gold layer is solid and brilliant, but when the bismuth content is increased, the grains multiply and the coloring changes to gray. The relations between the stabilizing rôle of bismuth in the gilding, the length of firing, and temperature were studied with a special apparatus. To obtain a stable gilding on ceramic objects it is necessary to heat them to 760°C. The heating and cooling should be progressive and slow. **III. Action of other metals with the exception of bismuth and rhodium.** *Jour. Soc. Chem. Ind.* [Japan], **34** [5], 166*B* (1931); *Chim. & ind.*, **26** [5], 1129 (1931).—It was found that the additions of chromium, aluminum, iron, and ruthenium may prevent the formation of grains and produce a layer having a golden luster. The preserving action of chromium is not exerted over 650°. For higher temperatures, rhodium should be used as a refractory metal. The study of the action of the increasing quantities of chromium in gilding composed of gold, rhodium, bismuth, and chromium showed that the quantity of chromium over 1.27% of the total darkens and dulls the tint of the gilding in spite of absence of grains; this fact especially distinguishes the action of chromium from that of rhodium. M.V.K.

Educating the public to demand the best in American creative art. WALTER P. SUTER. *Bull. Amer. Ceram. Soc.*, **11** [1], 3–6 (1932).—As the public has become more discriminating in buying some of its household conveniences, silver and pewter and other items, they should also be educated to appreciate fully the beauty, utility, durability, etc., of American ceramic products. Suggestions of magazine articles to disseminate information regarding ceramic articles and a traveling exhibition of various ceramic products are offered as means whereby this object may be attained. E.J.V.

Studies in shape construction. Series III. PAUL BOGATAY AND ARTHUR E. BAGGS. *Bull. Amer. Ceram. Soc.*, **11** [1], 6–11 (1932).—Using the type forms selected by Alexander Sandière of Sèvres, known as "Sandière blocks," this series illustrates a simple, systematic method for the development of suitable ceramic shapes by varying the proportions of single fundamental forms or combinations of related forms. Illustrated with charts. See also *Ceram. Abs.*, **10** [11], 788 (1931). E.J.V.

Memorial collection of Robineau porcelains. ANNA W. OLMSTED. *Design*, **33** [7], 153 (1931).—The Memorial collection of porcelains by Adelaide Alsop Robineau was purchased last year by the Syracuse Museum of Fine Arts. Her revival of ancient

Chinese glazes, considered a lost art, was remarkable work. She once demonstrated at Sèvres, using her favorite Texas clay, that plastic porcelain could be thrown on the wheel. Illustrated. E.B.H.

Rare porcelain set with semiprecious stones. ANON. *Arts & Dec.*, **36** [2], 49 (1931).—Both antique and modern porcelains combined with semiprecious stones such as carnelian and mutton fat jade are illustrated. E.B.H.

Cut-glass etchings. ANON. *Nat. Glass Budget*, **47** [36], 15 (1932).—The old-time trade of glass cutting has been raised to the level of a fine art by Tracy W. Marks. With nothing but the regular tools of his trade, mostly homemade to suit his own requirements, this craftsman has achieved designs up to now unknown to the medium of cut glass. For the most part his etchings have been of sailing vessels. E.P.R.

Modern stained glass and painted glass. JAMES HOGAN. *Pottery Gaz.*, **57** [655], 91 (1932).—The term "stained glass" is defined and a brief discussion of the history of the art is presented, tracing it from its early days to the present. The use of this type of glass in the decoration of buildings is taken up. E.J.V.

Present development of artistic glass. MAUDER. *Glashütte*, **61** [45], 817–18 (1931).—M. discusses the present development of decorating, etching, cutting, and ornamenting glass with enamels, gold, and silver. M.V.K.

Modern glass from all over the world. ELIZABETH LOUNSBERY. *Arts & Dec.*, **36** [3], 16–19 (1932).—Crystal has somewhat superseded color, although color will always prevail, toning with the colored damasks now used. The first Italian glass introduced into America was most ornate but has given place to plain glass with perhaps a colored stem, fragile, and simple. A new rendition is the Italian opaque glass, ivory tones suggesting porcelains and providing decorative forms and flowers. The Swedish Orrefors table glass in plain unetched patterns has such delicate color of faint smoke, mauve, or pale blue that it can be detected only in full light. Etched Orrefors is especially effective used with rayon damask which provides the necessary sheen as a background. Modern French, Austrian, and German glass favors crystal. Lalique and Baccarat are particularly successful. In the German Swiesel and Siesmuth glass, geometric patterns and swirling lines form the decoration American glass has shown notable advancement since Sandwich with its rugged beauty, and has kept pace with Europe especially in cheaper grades, showing clever reproduction of the better imported ware. The Steuben Piedmont pattern by the Corning Glass Works is an example of American production at its best in etched modernistic crystal. Dulany luster plates have recently won distinction through artistic merit. Illustrated. E.B.H.

Crystal and luster. ANON. *Arts & Dec.*, **36** [2], 48 (1931).—Reproductions of crystal and luster goblets, candle holders, toilet bottles, jars, etc., with many types of decoration are described. E.B.H.

Sandwich type of pressed glass. CARL GREENLEAF BEEDE. *Christian Sci. Mon.*, **23** [304], 9 (1931).—An exhibit of American blown glass at the Art Center in New York consisting largely of Sandwich glass is discussed. An explanation of the type of glass generally covered by this title is given. E.J.V.

Early American glassware at Toledo Museum of Art. ANON. *Amer. Glass Rev.*, **51** [14], 13–14 (1931).—Examples of American glass are shown in a collection of bottles on view in the school of design corridor in the Toledo Museum of Art galleries. E.P.R.

Heraldic glass at Bramall Hall. F. SYDNEY EDEN. *Connoisseur*, **88** [362], 253–56 (1931).—Bramall Hall, Cheshire, holds some fine examples of heraldic glass painting done in England in the 15th Century. The colored glass is pot metal and the charges are boldly designed and spaced. In many cases the cutting and leading of the glass show a high skill in craftsmanship. Illustrated. E.B.H.

Modern artistic glasses. W. E. S. TURNER. *Amer. Glass Rev.*, **51** [12], 13–14 (1931).—Lectures on various aspects of glass manufacturing have marked a recent exhibition of modern glasses in the Science Museum, South Kensington, London. A variety of opinions as to how glass is made are held by the general public and T. in opening his address used lantern slides to illustrate manufacturing and decorating processes. See also *Ceram. Abs.*, **11** [2], 94 (1932). E.P.R.

Contemporary American ceramics. BLANCHE NAYLOR. *Design*, **33** [7], 160–63 (1931).—The purpose of the display of American ceramics conducted by W. & J. Sloane in New York is to further the cause of art in industry and to promote recognition of fine design in small potteries. The representation is excellent showing great variety of design expressed in clay. Illustrated. E.B.H.

Pottery of today in America. CARL GREENLEAF BEEDE. *Christian Sci. Mon.*, **23** [304], 9 (1931).—A description of some of the outstanding exhibits of various forms of pottery by individuals at the exhibition at W. & J. Sloane in New York during November, 1931, is given. Illustrated. E.J.V.

French faience and table china. ANON. *Arts & Dec.*, **36** [2], 33 (1931).—Several illustrations are given of tableware, figures, and a variety of boxes in faience and china. E.B.H.

Old and new china for tables. JULIET AND FLORENCE CLARKE. *Arts & Dec.*, **36** [3], 34–35 (1932).—In many instances the very latest styles are duplicates of those of the earlier centuries, including Victorian ware, the silver and gold lusters of England, 1790, hunt china, fish and game plates, prints of famous paintings, historic English and Colonial patterns, salt glaze, etc. Recently original molds and copper-plate engravings have been used. Entirely new are (1) dessert plates in pale pink glaze combined with cobalt, pink, or yellow with central medallions of native American flowers in natural colors and (2) duotone, a square-shaped china with gadroon edges showing pink, green, or blue on one side with ivory on the reverse. Full descriptions and many illustrations are given. E.B.H.

English medieval inlaid tile. BERNARD RACKHAM. *Connoisseur*, **88** [363], 291–95 (1931).—The lead belongs to England in the branch of art called encaustic or inlaid tile, dating from the 13th Century and hardly surviving the Gothic period because of the introduction of majolica, a method more easily adaptable to the much-used heraldic design. The method of inlaying was to impress the design in intaglio in the soft clay by means of a wooden stamp and to inlay the ornament in clay of another color, usually white on red ground. Their interest lies in the fact that they depend solely on proportioned contrast and interesting contour of color, sober in hue. Photos by Brian C. Clayton record the best collection since Shaw's Specimens of Tile Pavements in 1858. Illustrated. E.B.H.

Unearthing America's ancient history. S. G. MORLEY. *Nat. Geog. Mag.*, **60**, 99–126 (1931).—The Carnegie Institution has under investigation fifteen centuries of ancient Maya history. 28 photographs. H.H.S.

Cyprus pottery 4000 years old. P. DIKAIOS. *Illus. London News*, **179**, 678–79 (1931).—Unique pottery of extraordinary shapes has been unearthed in a necropolis of the Bronze Age at Vounous near Kyrenia. Ten photographs. H.H.S.

K'ang Hsi porcelain enameled on the biscuit. ANON. *Connoisseur*, **88** [362], 257 (1931).—An aubergine and a green bowl of the K'ang Hsi period are illustrated. E.B.H.

China in Siam. ANON. *Christian Sci. Mon.*, **24** [37], 9 (1932).—Some of the early "duck's egg blue crackled" china called Swanakaloke china was produced by Chinese potters who had come to Siam in the 17th Century. About 1720, green ware was produced for the royal family. The coloring of this ware is mainly a soft shade, similar to

Chinese jade green, but there are decorations in about seven colors, including black, pink, and rust. Around the outside appear, in primrose yellow on black, figures of Buddha in his various incarnations. Illustrated. E.J.V.

BOOKS

Index of Potters' Stamps on Terra Sigillata (Samian Ware). FELIX OSWALD. xxiii + 428 pp. F. Ostwald, East Bridgford, Notts, 1931. Price 36s. Reviewed in *Times Lit. Supp.*, **30**, 779 (1931). H.H.S.

Wallace Collection Catalogues of Terra Cotta, etc. J. G. MANN. xxiv + 238 pp., 99 plates. Wallace Collection, London, 1931. Reviewed in *Times Lit. Supp.*, **30**, 780 (1931). H.H.S.

Early English Drug Jars. G. E. HOWARD. 50 pp., 22 plates. Medici Society, London, 1931. Price 10s 6d. Reviewed in *Times Lit. Supp.*, **30**, 803 (1931).—Eighty-seven examples of "Lambeth Delft," Jacobean wineglasses, and other specimens dating between 1650 and 1740 are discussed and illustrated. H.H.S.

Colour Science. Part I. Theory and Standardization.. W. OSTWALD. Translated by J. S. Taylor. Price 15s. Reviewed in *Times Lit. Supp.*, **30**, 795 (1931); for abstract see *Ceram. Abs.*, **11** [2], 76 (1932). H.H.S.

Corinth. Vol. IX. Sculpture. F. P. JOHNSON. Harvard Univ. Press, 1931. Price $5.00. Reviewed in *Times Lit. Supp.*, **30**, 819 (1931).—The results of the excavations conducted by the American School of Classical Studies at Athens are recorded. H.H.S.

The Tomb of Ken-Amun at Thebes. N. DE G. DAVIES. 2 vol. Vol. I, x + 70 pp., 70 plates; Vol. II, plates in folio. Metropolitan Museum of Art, New York, 1931. Price $3.00. Reviewed in *Times Lit. Supp.*, **30**, 829 (1931). H.H.S.

The Sarcophagus of an Ancient Civilization: Petra, Edom, and the Edomites. G. L. ROBINSON. Introduction by W. F. Albright. xxiii + 495 pp. Macmillan, London, 1931. Price 31s 6d. Reviewed in *Times Lit. Supp.*, **30**, 832 (1931). H.H.S.

Book Review

Noted Porcelains of Successive Dynasties. HSIANG YÜAN-PIEN. Revised and annotated by Kuo Pao-ch'ang and John C. Ferguson. Published by the Chih Chai Publishing Co., Peiping, 1931. Price Mex. $300. This is a new translation of the Album of Hsiang Yüan-pien, 1525–90, with its comments and illustrations. It is based upon a copy of the original Album in the possession of Mr. Kuo. Mistakes in the copy have been corrected and the meaning of the text explained by numerous annotations of the authors. The book is printed on special paper made on deckles of pulp obtained from young bamboos. This paper was prepared after the formula of the celebrated Ch'êng Hsin T'ang paper of the Southern T'ang dynasty. This quality of paper will last for hundreds of years in any climate. It is specially adapted for lithographic work as it will take any number of impressions without injury to its surface.

The colors of the illustrations have been verified by existing specimens of Sung, Yüan, and Ming porcelains. Each of the eighty-three specimens is explained in the Chinese and English languages and the explanation is on the page directly opposite to the illustration, thus facilitating their study.

The authors have contributed a preface and a sketch of the life of Hsiang Yüan-pien of whom a portrait is given. There is an account of the ink palette used by Hsiang with four illustrations. The table of the colors of the glazes of the various objects is invaluable for reference.

Of the 83 illustrations, 12 are of Ting ware, 4 are of Chün, 1 of Tung, 3 of Ju, 10 of Kuan, 1 of Ko, and 11 of Lung-ch'üan ware, all of the Sung dynasty. There is only

one example of Yüan dynasty ware. Of the Ming dynasty types there are 1 of Yung Lo, 20 of Hsüan Tê, 11 of Ch'êng Hua, 4 of Hung Chih, 2 of Chêng Tê, and 2 of Yi-hsing ware. These form a background for the study of the porcelains of the K'ang Hsi, Yung Chêng, and Ch'ien Lung periods in which collectors have so far been chiefly interested.

The book is bound in covers of yellow silk protected by a stiff paper box which can be placed upright on a library shelf or laid flat on a table. This box is also protected by an outside wrapper of thick paper.

Careful attention has been given to every detail in the preparation of this book. The Chinese text looks as if it had been written and the illustrations as if they were hand paintings. The English text has been printed with type specially cast.

PATENTS

Design for plate, etc. THOMAS C. MERRIMAN. U. S. 85,837, Dec. 22, 1931. JESS CLAIR KELLY. U. S. 85,880, Dec. 29, 1931. URASABURO TOMITA. U. S. 85,963, Jan. 5, 1932.

Design for jar. OLBERT C. NOBLE. U. S. 85,838, Dec. 22, 1931. EDWIN WENDELL FUERST. U. S. 85,926, Jan. 5, 1932.

Design for covered dish. THOMAS C. MERRIMAN. U. S. 85,836, Dec. 22, 1931.

Design for soap holder, etc. STEPHEN D. BAKER. U. S. 85,849, Dec. 29, 1931.

Design for bathroom toothbrush holder. STEPHEN D. BAKER. U. S. 85,850, Dec. 29, 1931.

Design for grab rail, etc. STEPHEN D. BAKER. U. S. 85,851, Dec. 29, 1931.

Design for celery tray and mayonnaise dish. JESS CLAIR KELLY. U. S. 85,878 and 85,879, Dec. 29, 1931.

Design for bottle. EDWIN W. FUERST. U. S. 85,925, Jan. 5, 1932.

Design for vase. MARGARET LINDALE DUGDALE. U. S. 85,918 and 85,919, Jan. 5, 1932.

Design for lighting fixture. BERTRAM L. WATKIN. U. S. 85,965, Jan. 5, 1932.

Design for restaurant type coffee maker. FRANK E. WOLCOTT. U. S. 85,966, Jan. 5, 1932.

Design for drinking fountain bubbler head. ROY H. ZINKIL. U. S. 85,968, Jan. 5, 1932.

Design for range. CLARENCE V. ROBERTS AND WILLIAM D. ANTRIM. U. S. 85,992, Jan. 12, 1932.

Design for ash tray. JOHN KIRKPATRICK. U. S. 85,983, Jan. 12, 1932.

Design for kitchen range. LEWIS MOORE. U. S. 85,985, Jan. 12, 1932.

Design for gas and electric range. CLARENCE V. ROBERTS. U. S. 85,991, Jan. 12, 1932.

Coloring enamel, glazings, glass, etc. DEUTSCHE GASGLÜHLICHT-AUER-GES. Brit. 361,898, Dec. 9, 1931.

Decorating porcelain, etc. R. H. SCHLINDENBUCH. Brit. 362,253, Dec. 9, 1931.

Cement, Lime, and Plaster

Thermochemistry of Portland cement. Study of the heat of formation of alite and Jänneckeite. OTTO FR. HONUS. *Chim. & ind.*, **26** [5], 1011–22 (1931).—(1) A study of the formation of Portland cement from the thermochemical point of view and practical values of the heat consumed in different types of kilns are given. This study contains details concerning the decomposition of clay and of carbonate of lime necessary to the

formation of silicates and aluminates. The temperature and pressure of dissociation of calcium carbonate is also given. The heat of the molecular formation of the compound $(3CaO{\cdot}SiO_2)_4{\cdot}(3CaO{\cdot}Al_2O_3)$, which approximates most of the composition of alite and which is considered as a chemically definable Portland cement, is −561,100 cal., starting with $CaCO_3$, SiO_2, and Al_2O_3; or for 1 kg. it is −474.6 cal. Calculated from $15CaO + 4SiO_2 + Al_2O_3$, the molecular heat is +116,150 cal. and for 1 kg. it is +77.2 cal. The heat of formation of the compound from the elements $15CaO + 4Si + 2Al + 13O_2$, is +3,201,250 cal. (molecular heat) and +2708.3 (per kg.). (2) The heat of formation of Jäneckeite ($8CaO{\cdot}Al_2O_3{\cdot}2SiO_2$) can be easily separated. The heat of formation of this compound, beginning with pure clay and pure $CaCO_3$, *viz.*, $8CaCO_3 + 2H_2O, Al_2O_3, 2SiO_2 \longrightarrow 8CaO, Al_2O_3, 2SiO_2 + 2H_2O$ (steam), is −346,236 cal. (per molecule) and −515 cal. (per kg.). Beginning with lime and clay, according to the equation $8CaO + 2H_2O, Al_2O_3, 2SiO_2 \longrightarrow 8CaO, Al_2O_3, 2SiO_2 + 2H_2O$ (steam), one obtains +14,966 cal. (molecular heat) or +22.3 cal. (per kg.). If the water changes into the liquid state during this reaction, there are 36,800 cal., and 54.9 cal. $2SiO_2 + Al_2O_3 + 8CaO$ give +58,800 cal. (molecular heat) and +87.7 cal. per kg. of Jäneckeite. Finally, the heat of formation from the elements $8CaO + 2Si + 2Al + 7^1/_2O_2$, is + 1,861,000 cal. or +2777 cal. for 1 kg. M.V.K.

A theory regarding the silicates in the chemistry of cement formation. R. Zollinger. *Zement*, **20** [8], 738–41 (1931); *Pit & Quarry*, **23** [5], 57–59 (1931).—The silicates can be divided into three groups, (1) the metasilicates, (2) the orthosilicates, and (3) the silicates of the complex sesquioxide types. The production of cement consists in decomposing the minerals and building new chemical compounds. Fluxing or decomposing takes the same course as the decomposition of the original minerals in nature, in that simple silicates are formed from the high-molecular sesquioxide silicates. This process shows itself outwardly in an increasing solubility of the minerals of the original rocks and because of this solubility, constituents of the minerals disappear, being taken into solution and carried away by the water. When decomposing minerals in the laboratory soda is used in connection with heat, but in large-scale industrial decomposition lime is used. What actually takes place is that lime or the compound of type MO has chemically a greater affinity for SiO_2 than the compound of type M_2O_3. If the stable metasilicate MO SiO_2 has been formed, then further addition of MO will separate the silica from the M_2O_3 so as to again be able to form MO SiO_2. Further addition of MO even reduces the rôle of the sesquioxide, and compounds of the type MO M_2O_3 result in which the M_2O_3 must take over directly the functions of the SiO_2. If the quantity of MO is increased still further, then the genuine supersaturation of MO takes place which theoretically can be continued to the types 3MO SiO_2 and 3MO M_2O_3, the ideal case in cement. Cement in its ideal form consists of the two components 3MO SiO_2 and 3MO M_2O_3. The actual quantity of silicate in proportion to the quantity of aluminate or ferrate depends on the raw materials. Recent clays which still contain a good deal of M_2O_3 MO $6SiO_2$, *i.e.*, unreduced feldspar, will normally yield cements whose silicate content is preponderant. To express cement or cement substance in a formula, this must take the form of x (3MO SiO_2) y (3MO M_2O_3), in which x and y are dependent on the raw material or on the admixtures used. Limiting formulas of good cements are 6 (3MO SiO_2) 1 (3MO M_2O_3) to 2 (3MO SiO_2) 1 (3MO M_2O_3). E.P.R.

Significance of the thermal dissociation of iron oxide for the firing of cement. Hans Kühl and Rudolf Rash. *Zement*, **20** [36], 812–16; [37], 833–36 (1931).—(1) Through gas volumetric measurements, it is shown that the dissociation of pure iron oxide is visible in an oxygen atmosphere at 1440° and proceeds turbulently at 1500°. The reaction decreases, however, long before the main quantity of iron oxide disintegrates.

The reason for this lies in the possibility of the formation of solid solutions from iron oxide and ferrosoferric oxide. (2) In systems containing lime, the dissociation of iron oxide is greatly checked; the larger the lime content, the smaller the dissociation is. With a temperature of 1500°, length of time of 20 min., and an oxygen atmosphere, only a small fraction of iron oxide content is converted into ferrosoferric oxide in a Portland cement rich in iron oxide. (3) Although the cleavage of oxygen during the normal operation of a technical cement kiln can play only a small rôle, this splitting-off conditions the consumption of potassium permanganate in most Portland cements. (4) It seems that the greenish-black color of Portland cement clinker is mainly conditioned by its content of ferrosoferric oxide. The appearance of brown, red, and red-brown color tones can be explained by the "competition" between ferrosoferric oxide, iron oxide, and ferrites of the lime. M.V.K.

Formation of tricalcium silicate with technical firing. I. WEYER. *Zement*, **20** [31], 714 (1931).—From the fact that in synthetic raw powders tricalcium silicate is formed at 1300°, it can be assumed that the temperature of formation of this compound lies at lower temperatures when using technical raw powders. Although the firing of technical powders is somewhat shorter than that of synthetic powders, the appearance of a liquid state at 1270° in technical powders promotes the course of reaction and the formation of tricalcium silicate. The results of researches of W. Dyckerhoff, H. Kühl and Lorenz, W. Schrieder, and C. Prüssing are discussed. See also *Ceram. Abs.*, **11** [2], 78 (1932). M.V.K.

Arsenic as a means of making cement acid resisting. ANON. *Tonind.-Ztg.*, **55** [60], 878 (1931).—In No. 2 of the journal "Technical News for the Painting Industry," June, 1931, the use of arsenic as an addition to cement is emphasized to protect it against attacks by water and acids. The use of arsenic, however, is very dangerous and should be avoided entirely. A number of means are known to give the same protection to the cement. W.M.C.

Arsenic as a means of making cement acid resisting. R. GRUEN. *Tonind.-Ztg.*, **55** [102], 1416–17 (1931).—The former paper on the same subject is criticized (see above abstract). The price of arsenic trioxide is very low. Arsenic trioxide decreases the solubility of cement, but blast-furnace slag added to the cement will have the same effect. On account of the highly poisonous effect of arsenic trioxide, this material should not be used commercially for protecting the cement. See also *Ceram. Abs.*, **10** [11], 754 (1931). W.M.C.

Reaction between water and cement. HANS KÜHL. *Tonind.-Ztg.*, **55** [101], 1399–1401 (1931).—The reactions between water and cement were studied by a new method developed by Wang. Instead of fine cement, cement grit is exposed to water saturated with lime, and the reactions at the boundary surface are studied. A small amount of tricalcium aluminate and only traces of the hydrosilicates are soluble in lime water. In the beginning, more hydroaluminates are formed than hydrosilicates. The reaction takes place to a depth of 0.2μ within 24 hr. and to 6μ after 90 days. Berchem found that with pure water and alumina cement grit, dicalcium hydroaluminate is formed, the aluminates react quicker than the silicates, and the time of reaction is considerably reduced. The depth of attack amounts to 0.4μ for one hr. and 5μ for one day. W.M.C.

Addition of calcium chloride to cement. L. DAVID. *Tonind.-Ztg.*, **55** [97], 1339–40 (1931).—The addition of calcium chloride to cement clinkers will improve the strength of the cement in the beginning of the hardening process. An addition of from 5 to 7% of calcium chloride to the water used in preparing the concrete will make the hardening process possible to as low a temperature as −5°C. The disadvantages of the addition of large amounts of calcium chloride are seen in the possibility of rusting of the iron in

reinforced concrete buildings and the large amount of shrinkage. The possibility of replacing calcium chloride is emphasized. The hardening of concrete often takes a long time if in laying the foundations of buildings the soil is used as a form. W.M.C.

Progress of the reaction between kaolin and lime with static heating. I. WEYER. *Zement*, **20** [24], 560–64; [26], 608–12; [30], 692–94 (1931); for abstract see *Ceram. Abs.*, **10** [2], 158 (1931). M.V.K.

Effect of carbonic acid and acetic acid on Portland cement. HANS TH. BUCHERER AND F. W. MEIER. *Zement*, **19** [48], 1134–38 (1930); *Rock Prod.*, **34** [26], 64 (1931); for abstract see *Ceram. Abs.*, **10** [6], 409 (1931). W.W.M.

Discoloration of Portland cement clinker. ARTHUR J. POOL. *Rock Prod.*, **34** [26], 50–52 (1931).—P. gives a review of the literature on discoloration of Portland cement clinker. He describes experiments made by himself and discusses the results. The conclusions are as follows: (1) A reducing condition acting upon clinker at high temperatures is probably essential to discoloration. (2) The presence in the raw mix of relatively large amounts of iron and sulphur is in all probability a contributing factor toward discoloration. (3) The presence of ferrous iron in discolored clinker is regarded as an accompaniment and not as an essential for discoloration. (4) Sudden cooling of clinker is not a primary cause of discoloration. (5) The exact cause or causes of discoloration of clinker have not been satisfactorily explained. W.W.M.

Keene's cement: Its use and manufacture. JOHN C. BEST. *Rock Prod.*, **34** [26], 47–48 (1931).—B. outlines the differences between Keene's cement and other gypsum plasters, its characteristics, and the manufacturing process. A description of troubles as are sometimes encountered in using Keene's cement, how to identify them, and how they may be avoided is also given. See also *Ceram. Abs.*, **10** [7], 482 (1931). W.W.M.

Manufacture of supercement in automatic vertical kilns. ANON. *Rev. mat. constr. trav. pub.*, No. 265, p. 411 (1931). M.Y.H.

Some special uses of plaster and carbonate of lime. M. JODE. *Rev. mat. constr. trav. pub.*, No. 264, p. 369 (1931).—The use of plaster is described in detail in the following projects: (1) the making of molds from clay, plaster, wood, and marble models, (2) making a piece mold, (3) making a glue mold, (4) making a rubber mold, (5) reducing the size of plaster molds by the use of alcohol, and (6) the action of certain salts to retard or accelerate the setting of plaster and to give it a fine polish. M.Y.H.

Pottery mold shop economies. R. B. LADOO. *Fuels & Fur.*, **9** [6], 735–38 (1931).—In making pottery molds, the highest grade of plaster is the most economical. The following points should be observed: (1) The plaster should be stored in a dry, well-ventilated place. (2) The best water-to-plaster ratio for the type of molds to be made should be determined. (3) The plaster should be weighed and the water measured. (4) It should be mixed for a definite uniform time with a mechanical mixer. (5) The molds should be dried in a well-ventilated room at not over 150°F. The advantages of machine mixing are (1) maximum strength, (2) uniform texture, (3) no visible voids, (4) uniform setting time, (5) soaking time eliminated, (6) a heavier mix may be used, and (7) mixing time is reduced and hand labor eliminated. Set-up plaster acts as a set-accelerator and hence all mixing buckets, etc., must be kept scrupulously clean. Elimination of air bubbles is helped by jarring or bumping the molds before setting begins. In dental laboratories, mechanical mixing and vibrating of the molds is practised to eliminate air bubbles. In this way it has been possible to increase the strength 40%. The use of molds without sufficient drying between castings results in soft surfaces. Deflocculents in the clay considerably shorten the mold life by chemical reaction. A.E.R.W.

Twelve years of "high-grade" cement. OTTO GASSNER. *Zement*, **20** [19], 432–36

(1931); *Rock Prod.*, **34** [26], 64 (1931).—G. reviews the development made on "high-grade" cement in the last 12 years, giving 104 references to the literature on the subject. The high-grade Portland cement, high-grade iron Portland cement, and high-grade blast furnace cement are distinguished from Portland, iron Portland, and blast-furnace cement primarily by their high initial strength. W.W.M.

Colloidal cement hardening. I. HANS KÜHL. *Zement*, **19** [12], 262–64 (1930).—K. discusses the theories of Le Chatelier, Michaelis, Biehl, Gonell, and others on the crystalline hardening of cement, and describes his own tests with synthetic slag composed of silica, alumina, iron oxide, magnesium oxide, and calcium carbonate treated with caustic potash solution. The microscopical and technical tests showed no crystal formation but a hydraulic hardening of the substance. The results of X-ray investigations were completely negative in all cases, and no crystal formations appeared during the hardening time. This is proof that a hydraulic hardening is possible without any traces of crystal formation. **II.** *Ibid.*, **20** [28], 650–51 (1931).—The researches were continued on new preparations made from precipitated calcined silica, precipitated aluminium hydroxide, and precipitated calcium carbonate treated with a 20% caustic potash solution. The hardened products were investigated by X-rays and showed no crystal formations. It can be assumed, therefore, that a hydraulic hardening as observed in cement of high quality is due to a colloid-chemical principle, *i.e.*, without the appearance of the coarse mechanical matting of crystals. See also *Ceram. Abs.*, **9** [3], 155 (1930). M.V.K.

PATENTS

Acid-proof cementing compositions. ANTON GRAMBERG. U. S. 1,837,614, Dec. 22, 1931. An acid-proof cementing composition obtainable by intimately mixing with 400 parts of water-glass a cement powder consisting of 800 parts of a silicon alloy composed of 85% silicon and 15% iron, 150 parts of clay powder, and 50 parts of sodium silicofluoride, the composition being characterized by its excellent thermal conductivity and hardening power.

Plastic magnesia mixture. HIRAM S. LUKENS AND NICOL H. SMITH. U. S. 1,838,147, Dec. 29, 1931. As a new composition of matter, a mixture of magnesium oxide, magnesium chloride, magnesium sulphate, and aggregate in such proportions that the amounts of magnesium oxide, magnesium chloride, and magnesium sulphate are within the ratio of one part by weight of magnesium oxide to from 0.84 to 1.3 parts by weight of $MgCl_26H_2O$ and magnesium sulphate ($MgSO_47H_2O$) and the ratio of the amount of aggregate to the combined amounts of magnesium oxide, magnesium chloride, and magnesium sulphate is such that the amount of water required to produce a mix of proper consistency for manipulation will not be in excess of that amount which would produce a solution of 16° Bé if the amount of magnesium chloride (and magnesium sulphate) in the mixture were dissolved therein.

Enamels

Feldspar. VIELHABER. *Emaillewaren-Ind.*, **8** [49], 391–92; [50], 397–98; [51], 406–407 (1931).—There are three kinds of feldspar, potash feldspar, soda feldspar, and lime feldspar. These feldspars have different properties and their use as raw materials for enamels varies. Examples for calculating feldspar according to its composition are given and the American classification of feldspar is explained. The alkali content of a good feldspar should be as high as possible and it should not contain any free quartz or clay. The lime content is not important. The alumina of the feldspar increases the

expansion of an enamel but decreases its elasticity and acts as an opacifier. Alkalis also increase the expansion, soda more than potash. Elasticity is increased more by the latter than by the former. A mixture of different minerals increases the fusing interval of an enamel and therefore feldspar is used with quartz. The largest fusing interval is obtained by adding $^1/_3$ quartz and $^2/_3$ feldspar or inversely. The proportion of 1 quartz to 1 feldspar is the worst. M.V.K.

Determining the additions to the mill in enamels. VIELHABER. *Emaillewaren-Ind.*, **8** [43], 343–44 (1931).—The following method is used for analytically determining the constituents of a finished enamel which has already been ground: The mass is sifted with water. The fine enamel grains remain as residue while the clay and tin oxide are washed off with the finest particles of the enamel. The residue is investigated with a microscope. When two enamels of the same color are mixed, the residue should be analytically investigated. The solid constituents deposit in the water and are dried and analytically determined. These constituents may be determined from the results of the analyses by deduction because the composition of the enamel is known from the first analysis. The remainder of alumina and the silica found must show the quantity of clay used. An excess of silica shows an addition of quartz. Tin oxide, antimony, etc., give the quantity of opacifiers used. If borax, soda, or other soluble salts are added to the mill they are lost during washing. Special tests should be made to determine these salts. A much simpler process is the mechanical separation of the mixture. The constituents of a mixture can be isolated by centrifuging because these constituents have different specific gravities; that of an enamel is between 2 and 3, tin oxide 6.95, water 1, and clay 2.5. M.V.K.

Properties and importance of water in the preparation of enamels. ANON. *Emaillewaren-Ind.*, **8** [48], 61–62 (1931).—Water is an important factor in the preparation of enamels. During fusion of an enamel, the water evaporates but leaves a solid residue increasing in quantity. The same is true with the water added during grinding of the enamel. This residue mixes with the enamel and depending on its content of sulphates, hydrosulphuric acid, iron, or organic matters may injure the enamel. The metals present in the enamel as lead, copper, tin, and iron decompose hydrosulphuric acid, combine with the sulphur and hydrogen, and form black spots. To avoid this, the quantities of sodium nitrate and potassium nitrate should be increased in the enamel because they promote the oxidation of sulphides. M.V.K.

Development of low-temperature enamels on a fluoride eutectic basis. JOHN F. HUNT AND R. M. KING. *Jour. Amer. Ceram. Soc.*, **15** [2], 116–21 (1932).

Apparatus for testing enamels and glazes for resistance to crazing under thermal shock. C. J. KINZIE. *Jour. Amer. Ceram. Soc.*, **15** [2], 112–15 (1932).

Observations in connection with physical tests for enamels. ANON. *Better Enameling*, **2** [8], 28–30 (1931). W.C.O.W.

Influence of the fineness of grinding on the properties of an enamel. ANON. *Glashütte*, **61** [48], 883–85 (1931).—The influence of grinding of the enamel slip on the working up of the same enamel and on the properties of the finished enamel was experimentally investigated and determined. Results are as follows: (1) Only a definite grinding time should be used for every enamel, depending on its constitution and on additions during grinding. (2) The most advantageous fineness of the enamel slip is that showing a systematically uniform distribution of the different sized grains. (3) A slip too coarsely ground may produce running off, unequal coating, adjusting difficulties, and poor firing; a too thin enamel may produce an irregular coating, underfiring, and formation of bubbles. (4) The colloidal action of clay is decisive for the behavior of the enamel and depends on the fineness of grinding of the latter. M.V.K.

Opacifying enamel with zirconium oxide. WILHELM LINKE. *Emaillewaren-Ind.*, **8**

[45], 358–59 (1931).—An especially efficient zirconium preparation for opacifying is terrar which is an opacifier containing zirconium oxide. It can be used for wet-coating for sheet and cast enamels and for a dry-coating such as powder enamel. Terrar is free from arsenic, antimony, barium, lead, and zinc and its opacifying action is as strong as that of tin oxide. A much better enamel is obtained in regard to coating power and luster when tin oxide and terrar are used together in the proportion of 1% tin oxide and 3% terrar. This zirconium preparation can be used also for enamels containing lead and is extensively used in ceramic glazes. See also *Ceram. Abs.*, **10** [8], 547 (1931). M.V.K.

Firing wet-process cast-iron enamels. ANON. *Better Enameling*, **2** [8], 14–38 (1931).—The method of drying, stacking, and firing of cast-iron enamels and some precautionary measures to be taken are given. W.C.O.W.

Gas-fired continuous conveyer type furnace used in firing vitreous enamel on steel parts. ANON. *Fuels & Fur.*, **9** [7], 843–46 (1931).—A description and diagrams are given of a furnace in the Peerless Enamel Products Co. It is constructed of brick encased in steel and is divided longitudinally, into two separate heating chambers, each with an overhead monorail conveyer. Opposite the center of the furnace are driers utilizing the waste heat from the hot zone. Each chamber of the furnace is divided into five sections. A.E.R.W.

Wider fusion range in enameling. ANON. *Ceram. Ind.*, **18** [1], 23 (1932).—The fusion range of porcelain enamel ground coat is discussed from the angle of the practical enameler. Use of more than one frit and the addition of silica sometimes aids in processing many kinds of ware. W.W.M.

Pickle room control for porcelain enameling plants. W. C. LINDEMANN. *Better Enameling*, **2** [8], 21–22 (1931); for abstract see *Ceram. Abs.*, **10** [10], 681 (1931). W.C.O.W.

Formation of wrinkles in porcelain enamel. ANON. *Glashütte*, **61** [45], 832–33 (1931).—Two kinds of enamel should be used for enameling bathtubs because the vaulted edges of the tubs have greater tensions than the flat sides of the tubs. The enamel used for the edge should have a higher expansion than that used for the sides, a difference of 10 to 20 points depending on the quality of iron. During enameling, both enamels are mixed to a certain extent and a silky luster, which consists of very fine waves, appears in the places where the enamels were mixed. The explanation of Zschimmer (*Sprechsaal*, Nos. 11 to 14 (1925)) of this phenomenon is given. If the assumption that the formation of fine waves is due to the formation of a solid "skin" on the surface which wrinkles, then the size of the wrinkles depends on the size of contraction (shrinkage) of the enamel. In order to regulate the shrinkage, it is necessary to know the expansion of the enamel in the temperature field where it changes from the liquid into the solid state. The "crystallization" of the enamel is another important moment. Enamels oversaturated with opacifiers tend to crystallize and precipitate the opacifier at a definite temperature and a silky luster or mat enamel results. An enamel which is not oversaturated with opacifiers and whose coefficient of expansion at the critical temperature is known will shrink the least within the "skin" and therefore show the smallest waves. Microscopical researches show the exact reactions taking place between the two powder enamels. Both enamels endeavor "mutually" to decompose during firing which is impossible, however, owing to the short time of firing. The greater the difference in the softening of the melting points between the edge and the interior powder, the more intensive is the reaction, and the more mat the enamel appears in this place. The melting points of both enamels should therefore be as close as possible because the greater this difference is, the more mat the enamel will be. M.V.K.

Black spots in enamels. ANON. *Glashütte*, **61** [47], 868–70 (1931).—Black spots in white enamels are generally caused by impurities of the enamel or by chemical conversions in the latter. They may be produced by dust during drying or during enameling, or by small particles of rust from the metallic frames used in drying installations. The mills may also cause them and great care should be taken during their cleaning. The enamel should be fused in covered crucibles so that light ashes and soot will not fall into the melt. Chemical reasons for the black spots are as follows: (1) They may appear if tin oxide is used as opacifier when it contains large quantities of metallic tin. Tin oxide should not contain more than 0.1% metallic tin. (2) The enamel should be fired with a pure oxidizing flame, otherwise a reduction of tin oxide into stannous oxide occurs producing the black spots. To avoid this reduction, the enamel batch should contain at least 6% saltpeter which counteracts the reduction in the melt and in the muffle. (3) Antimony oxide being very easily reduced may cause black spots which also may be prevented by additions of saltpeter. (4) The black spots may be caused by the metal of the object and by the ground glaze. If the sheet metal contains accumulations of carbon and is not thoroughly pickled, this carbon promotes reduction. Small bubbles are formed which later collapse but leave black spots. If the coating of the ground enamel is irregular and covers the places containing carbon very thinly or not at all, carbon reacts more strongly. A ground enamel with good covering power and containing sufficient borax and bonding oxides should be used. M.V.K.

Eliminating fishscaling. CHARLES MOGHABGHAB. *Ceram. Ind.*, **18** [1], 24 (1932).—M. lists all reasons which have been given by ceramists for fishscaling and tells how this defect was overcome in the plant of the Bellaire (Ohio) Enamel Co. The preparation of the metal is described and precautions necessary in making, applying, and firing the enamel are given. W.W.M.

Sheet metal and enameling. REINHARTZ. *Emaillewaren-Ind.*, **8** [49], 389–91 (1931).—R. discusses the composition of sheet metal and its relation to the appearance of bubbles, fishscales, cracks, and black spots on enameled objects. M.V.K.

Equipment for the cleaning of metal. XII. R. W. MITCHELL. *Metal Cleaning & Finishing*, **3** [12], 953–57 (1931).—Agitation is an invaluable aid in most cleaning operations, particularly with recessed parts, irregular surfaces, or where solid-particle-dirt is caked on. In the application of agitation to industrial cleaning a regular circulatory, nonturbulent flow is desired, the primary object being that the solution meet the surface to be cleaned at as high velocity as possible. Agitation may be secured by causing the solution to flow over the work or by moving the parts to be cleaned through the cleaning solution. Some of the means employed for agitation which are described include (1) ordinary convection currents due to heat, (2) agitation baffle plates or shields, (3) ejectors and injectors, (4) compressed air, (5) pumps, (6) propellers, (7) steam guns, and (8) electric cleaners. Illustrated. For Part XI see *Ceram. Abs.*, **11** [2], 84 (1932). E.J.V.

Cleaning metal surfaces. REX PRODUCTS & MFG. CO. *Metal Cleaning & Finishing*, **3** [12], 998–99 (1931); for abstract see *Ceram. Abs.*, **11** [2], 84 (1932). E.J.V.

Beginnings of the enamel industry. OTTO VOGEL. *Emaillewaren-Ind.*, **8** [43], 342–43; [45], 357–58; [47], 373–74 (1931).—A historical review of the development of the enamel industry is given. M.V.K.

First enameled house planned for erection in Cleveland. ANON. *Ceram. Ind.*, **18** [1], 18–19 (1932).—Developments and uses of enamel and steel in the erection of small units are discussed and some of the construction details of a complete steel and enamel house to be built in Cleveland are given. Any type of interior finish is possible in these houses. W.W.M.

Enamel patents. ANON. *Emaillewaren-Ind.*, **8** [50], 398–99 (1931).—A review of

the patent literature on enameling and improving the quality of enamels in the last three years is given. M.V.K.

BULLETINS

Stability of enamel suspensions. W. F. GAUSMANN. *Trans. Ceram. Research Inst.* [Leningrad], **33,** 38 pp. (1931).—H. studied the suspending action of some clays on three different enamels. $MgSO_4$, $NaCO_3$, $(NH_4)_2CO_3$, $Na_2B_4O_7$, and HCl were used as electrolytes. The suspending action of clay was determined according to the precipitate method. The dissolving of enamel frits during grinding was ascertained by titrating with 0.01 normal HCl for alkalis, and 0.01 normal KOH for anhydride of boric acid according to the method of Cook. A special apparatus (resistance-viscosimeter) was used for determining the degree of densening of enamel masses. The results were as follows: (1) The capability of suspension of clays can be judged only by the degree of their dispersion; their chemical composition has no influence whatsoever on their suspending action. (2) The presence of $CaSO_4$ in clays, even in minimum quantities, produces a coagulating action on enamel suspensions. (3) The composition of enamels and consequently their lixiviation during grinding exerts a certain influence on the suspensions because the alkalis and the borate of sodium which are liberated produce a different electrolytic action. (4) The liberated B_2O_3 (during grinding) contributes to the stability of enamel suspensions during deposition. A strongly alkaline medium produces a densening action on the enamel which changes after a certain time into a diluting action. Alkalis obtain OH-ions in the watery solution under the action of a hydrolytic dissociation and change the size of enamel and clay particles making them smaller. These particles become so small that they can no longer hold the larger particles in suspension since the enamel gel changes into a sol in alkaline solutions. (6) The viscosity of the mass is characteristic for the stability of an enamel suspension because the viscosity depends on the colloidal state of the mass; with the increase of the colloidal state, the viscosity of the mass increases also. (7) The aging of the enamel permits the use of a smaller amount of electrolytes and therefore decreases their injurious action on the enamel. (8) The apparatus used to determine the densening of the enamel mass according to the degree of viscosity proved to be efficient. (9) With the increase in temperature or quantity of water, the enamel mass becomes more dilute. M.V.K.

Antimony enamels. V. P. VAULIN. *Trans. Ceram. Research Inst.* [Leningrad], **29,** 31 pp. (1931).—V. discusses the harmfulness of enamels containing antimony and the solubility of the latter. According to V. the bromate method of Beck and Schmidt is the most suitable method for determining small quantities of antimony in enamels. M.V.K.

Glass

Alterability of glass. I. ALBERT GRANGER. *Céram. Verrerie,* No. 826, pp. 203–207 (1931).—Natural minerals such as feldspars are not absolutely unaltered when subjected to water vapor and carbon dioxide of the air but are slowly decomposed. Glasses do not have a definite composition but consist of complex solid solutions and do not escape this attack. The molecular ratio of alkalis to silica is about half that found in feldspar and there is little alumina found in glass. G. discusses the methods of determining the alteration of glasses, *i.e.,* the fuming hydrochloric acid test devised by Weber, the method of treating glass with water and evaporation with subsequent weighing of the dissolved salts, the titration of the alkalis devised by Mylius and Foerster, the use of iodeosine as a colorant devised by Mylius, the measurement of the altera-

tion with a microscope devised by Zschimmer, and the measurement of the conductivity of water in which glass has been placed by Kohlrausch. Haber and Schwenke used a drop test in which iodeosine was dissolved in ether which had been saturated with water. The alkalis set free by the water form an insoluble compound which deposits on the glass. The work of Foerster on the effect of mineral acids and water on glass is summed up, the heat effect of the action of water on potassium silicate which has been noted by Mylius and Foerster is discussed, and the work of Schwartz, Mylius, and Foerster on the relation of composition to alteration is reviewed. Mylius and Groschuff have studied the absorption of water by glass and the chipping of the surfaces of such glass when heated. **II.** *Ibid.*, No. 827, pp. 253–55 (1931).—G. sums up the work of Bunsen on the absorption of CO_2 by glass and states that CO_2 is only absorbed in the presence of water vapor. Warburg and Imhori determined the weight of water absorbed by glass and found that it amounted to from 0.001 to 0.005 mg. per sq. cm. of surface. Turner published a critical study of methods employed for determining the resistance of glass. Weber found that hydrochloric acid possessed a special corrosive action on glass. The work of Peddle on the measurement of the total alkalis set free and the errors that may occur on account of neglecting the other hydroxides present is discussed. The conclusions as found by Peddle concerning the measurement of resistance are as follows: (1) The shape of the vessel has an effect on the amount of glass going into solution. (2) The use of the autoclave does not duplicate conditions in service. (3) The process of determining resistance is very slow when plates of glass are used and for this reason crushed glass is more satisfactory. G. concludes that the best method is to determine the loss in weight where any solution is used and in the case of water, to determine the alkalis. If it is a case of precision the water should be evaporated. **III.** *Ibid.*, No. 828, pp. 317–20 (1931).—G. refers to Palmer's method which consists of boiling the glass for six hours. He discusses the formulas proposed by various investigators for the determination of the resistance. These formulas are based on the chemical composition. The heat treatment of glasses in the manufacturing process is an important factor as affecting the resistance, and a glass resistant to bases is not necessarily resistant to acids. The effect of different constituents on the resistance to various reagents is discussed. **IV.** *Ibid.*, No. 829, pp. 377–79 (1931).—G. states the reasons for the disagreements between the theoretical and the actual results obtained in relation to the alteration of glasses. These discrepancies are due to the preparation of samples, methods of analyses, etc. The work of various investigators concerning the resistance of glasses containing magnesia to the attacks of acids and bases is cited. T.N.McV.

Raw materials for glass. S. R. Scholes. *Fuels & Fur.*, **9** [7], 849–52 (1931).—S. discusses the kind and sources of oxides used in glass. A.E.R.W.

Glassmelting process. S. R. Scholes. *Fuels & Fur.*, **9** [9], 1079–81 (1931).—Glass is a mutual solution of silicates and silica. Freeing glass from gas bubbles is called "planing" or "fining." The temperatures in pots seldom exceed 2500°F, whereas in tanks, temperatures of 2700°F are common. Oxides, carbonates, nitrates, sulphates, and hydrates are the chief compounds used. Some of these evolve gases at low temperatures. Niter is the first to melt. It dissolves sodium carbonate and attacks the sand. In a tank the time necessary to bring the sand completely into solution is often less than one hour. In a pot it may be 20 hours. In continuous tanks, the "pull" or rate at which glass is drawn from the working end determines the time allowed for the planing process and must be gaged to the operating temperature. The most unfortunate accompaniment of the melting process of glass is the corrosion of the container. This is more rapid at higher temperatures. A.E.R.W.

Glassmelting in acid or basic pots. Anon. *Glashütte*, **61** [23], 420 (1931); *Chim. & ind.*, **26** [5], 1121 (1931).—The general opinion that pots with a high alumina content

are more resistant is not always confirmed. Good results were obtained with pots containing 72.3% silica, 21.6% alumina, and small quantities of lime. These pots yielded a perfect glass for 8 to 12 weeks. The fissures are easily resoldered. The pots are attacked especially by glass having a borax base. The manufacture of these acid pots is very easy, and the quality of the glass is much higher than that fused in basic pots. M.V.K.

Glazing glass pots with a protective coat. F. JOCHMANN. *Sprechsaal*, **64** [42], 774–75 (1931).—J. criticizes the so-called protection cement method (glazing) of lining glass pots with a mass of a similar composition as the batch but to which 5 to 10% feldspar powder is added. This glaze layer of a pot is more or less attacked with every fusion and such a porcelain-like glaze is not sufficient protection for the glass pot against the action of the fused glass. The pots having the longest life, up to 16 weeks, are those in which ordinary white glass with 1 to 2% K_2O is melted. Pots in which lead-borosilicate glasses are fused last from 8 to 10 weeks, and those for opal glass, up to 6 weeks due to the corroding action of fluorine. Unsuccessful attempts to cover glass pots with a protecting layer are described. M.V.K.

Glass decoloration. HUGO KUHL. *Glashütte*, **61** [45], 830–32 (1931).—The coloring of a glass is not caused by iron silicates alone. It is produced by sulphur which forms iron sulphide with traces of iron present coloring from yellow to brown. This glass colorizer appears easily when working with sodium sulphate. It can be avoided by using saltpeter, a strong oxidizing agent, or arsenious acid. There are two kinds of decoloration, (1) the additive and (2) the subtractive. The first is based on the formation of complementary colors and the second differs physically from the first and is based on the fact that the colors of bodies absorb light. The subtractive decoloration causes a light gray because much light is lost. An explanation of the nature of decoloration is given. Few decolorizers form complementary colors, although selenium and its salts and sometimes nickel oxide do. Subtractive decoloration is more often found. The oldest and most known decolorizer is pyrolusite. Glasses free from iron are colored violet to pink by manganese super oxide (pyrolusite). Glass decolorized by these two agents is never very clear and white due to the fact that much light is lost. Glass colored by manganese uniformly absorbs small quantities of the separate colors of the spectrum. Red and violet are the least absorbed; green, the most. The same is true for iron green glass although in an inverted proportion. Yellow and blue-green are transmitted more than red and violet. Attempts to use a cobalt decolorizer instead of nickel are discussed. The importance of firing, of uniform structure of the glass, and of keeping a constant temperature ratio is emphasized. M.V.K.

Fundamentals in glass technology. III. Decomposition and disintegration of glass. GEO. V. MCCAULEY AND C. D. SPENCER. *Ceram. Ind.*, **18** [1], 20 (1932).—Decomposition of glass due to weathering is discussed and described. Water is the reagent which produces the most pronounced effect. The water solubilities of glasses of various compositions and the change in composition due to weathering is shown. Calculation of the molecular formulas of glasses resistant to weathering is illustrated. Effects of the various constituents on water solubility are given. For Part II see *Ceram. Abs.*, **11** [2], 86 (1932). W.W.M.

Studies of defective glasses. LUDWIG SPRINGER. *Glashütte*, **61** [45], 827–30 (1931).—(1) Defects in glass are caused by a wrong proportion in the typical constituents forming glass. (*a*) Glasses with surplus alkalis and a simultaneous lack of lime or tin oxide contain from 4 to 5% lime and 18 to 20% alkalis and are distinguished by poor chemical and physical properties. With reheating, these glasses often form bubbles or become covered with a wrinkled skin or flakes. Acids like carbonic acid affect these glasses and separate the silica of the glass in the form of thin plates. (*b*)

Glasses with an excess in lime or tin oxide are inclined to devitrification and are not stable to acids. A high tin oxide content produces a yellow tone. Chemical apparatus glass should not contain zinc oxide, antimony oxide, or arsenic. Excess silica produces devitrification and decreases the chemical capability of resistance. (2) Glass defects are caused by excess or lack of secondary batch constituents or accidental impurities. (*a*) This is found in glasses with an injurious content of common salt or Glauber salt. Common salt increases the water-soluble ingredients of the glass and the volatilization of tin oxide and alkalis. It produces opacification and affects the color of the glass. (*b*) Sulphate may cause glass "gall" and its precipitation in white drops, and a slight cloudiness of the glass. (*c*) Defects are caused by a discoloration produced by lack of saltpeter or the wrong use of a decolorizer.' (3) Glass defects are sometimes due to defective mixing of the batch or melt, or originate from an insufficient melting temperature. (*a*) The formation of tubercules or streaks are caused by the incompletely dissolved constituents, *e.g.*, sand or feldspar. (*b*) The soiling of batch materials, especially potash, by phosphates or too high an addition of arsenic produces opalescent turbidities. (4 and 5) Glass defects are produced by soiling the glassware during melting or by exterior causes, *i.e.*, (*a*) knots from refractories and (*b*) metallic impurities. (6) Glass defects are conditioned by the dissimilar nature of the glass and the object combined with it. M.V.K.

Influence of cullet on the thermal stability of glass. M. A. Besborodov. *Ceramics & Glass*, **7** [9], 6–7 (1931).—The relations between the thermal stability of glass and quantity of cullet used was studied on three kinds of glass: (1) sodium-lime-silica glass, (2) laboratory glass, and (3) glass for electric bulbs. The results are tabulated. M.V.K.

Segregation of soda ash in glass batches. George Lynn. *Glass Ind.*, **13** [1], 1–4 (1932).—Using a simplified standard batch without cullet containing glass sand, limestone, and soda ash, mixed dry, and a standardized mixing procedure and sampling method, a study of the segregation of soda ash in the batch was undertaken. Samples of limestone and of sand from nine different glass plants and seven soda ash samples were used. It was found that of the four factors influencing segregation, *i.e.*, particle size, particle shape, density, and surface characteristics of the particle, size seems to be the controlling factor. It was concluded that since the sand is the principal batch constituent and is, in general, already sized by nature, it would be the best plant practice to call for screen specifications on the limestone and soda ash, conforming fairly closely to that of the sand actually used in each plant. It was obvious also that good plant practice is to eliminate, as far as possible, all batch handling operations where segregation can occur. E.J.V.

Making good glass from blast-furnace slag. C. A. Basore. *Chem. Met. Eng.*, **38** [12], 701 (1931).—A method has been worked out for making a light green or almost colorless glass from blast-furnace slag without removing any of its original constituents. The glass is suitable for bottles, jars, corrosion-resistant kettle linings, structural and decorative purposes, for X-ray bulbs, goggles, etc. Additions of sand to the slag were found necessary, ordinary building sand serving except where demand for a white glass would make the use of glass sand advisable. The mix used contained 7 parts slag, 8 sand, and 1.76 soda ash, with 5 parts hydrated sodium sulphate per 40 parts of the mix. Conservation of much heat was possible where slag from the furnace was poured direct from the blast furnace on top of the other materials contained in a fireclay crucible. See also *Ceram. Abs.*, **10** [9], 632 (1931). G.R.S.

Borosilicate glasses. Anon. *Glashütte*, **61** [4], 57 (1931); *Ceramics & Glass*, **7** [9], 59 (1931).—The composition of glasses which have a very high thermal and chemical stability and which can be used instead of quartz glass or porcelain is given:

	A (%)	B (%)	C (%)	D (%)
SiO_2	80–85	85	87.5	90
B_2O_3	16–12	13	11	9
Al_2O_3	2–1.5	1	0.75	0.5
ZrO_2	2–1.3	1	0.75	0.5

The temperature required for melting these glasses is not high. It is important that the per cents of the Al_2O_3 and ZrO_2 contents be equal. M.V.K.

Testing the resistance of tank blocks to the attack of molten glass in a model tank. A. DIETZEL. *Sprechsaal*, **64** [45], 828–32; [46], 846–51 (1931).—During the tests on tank blocks the following points were observed: (1) The test temperature was not permitted to fall below 1350 to 1400°, and not to rise above 1500°. (2) Only typical glasses or their batches used in industry were tested. Certain chemical reagents or raw materials (fluxes) can produce correct results only in certain cases as the blocks undergo quite different reactions in practice. (3) The time of the attack lasted for several days only. Several hours were not sufficient to ascertain the usability of blocks according to this method. (4) The surface of the samples to be attacked was at least 1 sq. decimeter. (5) The glass mass was stirred during the tests. (6) It was necessary to obtain falls in the temperature of the sample similar to the requirements of tank blocks in glassworks. The model tank was made from test pieces sawed from a tank block. The tank was heated to 1450° by illuminating gas. Every one-half hour a batch was put into the front end of the tank and the molten glass dropped from the other side of the tank was examined. The time of operation was from 7 to 14 days. After cooling the tank, the blocks were removed and investigated. The results of the tests are as follows: (1) This method of testing tank blocks in the laboratory reproduces the conditions taking place in practice. (2) The method does not give a complete valuation of a tank block in regard to its usefulness, but characterizes only the behavior of the block. It gives no information on the results of the wearing out of the block on the quality of the glass. The important question of stone and streak formations is also not explained. (3) The only disadvantages of this method are the long duration of the test (from 2 to 3 weeks) and a relatively high cost. M.V.K.

Testing the resistance of glass to bending and strokes. ANON. *Mitt. deut. Materialprufungsanstalten*, Nos. 3 and 4, pp. 53–54 (1929); *Sprechsaal*, **64** [45], 836 (1931).—Four different kinds of window glass used for greenhouses were subjected to bending and stroke tests in order to obtain data on their resistance to snow, wind pressure, and hail. Glass panes were loaded with different weights and the breaking load, strength, and sagging were determined. From the breaking load P in kilograms and sagging f in centimeters with such a load, the working ability A of the glass panes was calculated: $A = \frac{P \cdot f}{2}$ in cm./kg. As the stroke test showed, A is also a measure for the capability of resistance of glass strips to jerk requirements. A hammer of a known weight was permitted to fall from a definite height on the glass strips in the stroke tests and the work of the stroke causing breaking or the height of fall can be considered as a measure for the capability of resistance of glasses. It was found that the proportional numbers for the values ascertained by the bending tests for the working ability agree fairly well with those of the stroke work which cause breaking, in spite of large deviations in separate values. It is possible to consider the values for the working ability calculated from the breaking load by static bending tests and sagging by breaking as a measure for the valuation of the capability of resistance of glass plates of equal size to dynamic strains through stroke and shock. From the breaking load ascertained, the capability of resistance to latent loading may be determined. M.V.K.

Strength tests with mirror and machine glass. E. ALBRECHT. *Sprechsaal*, **64** [47], 868 (1931).—An arrangement for testing uneven mirror and machine glass plates of about 1 sq. m. surface and with a uniformly distributed load was developed. The change of the shape of the plates was measured and the lines of similar sagging ascertained. The bearing strength of the plates amounted to 250 to 500 kg./sq. m. according to the kind of glass used. The maximum sagging was up to three times the thickness of the plate. See also *Ceram. Abs.*, **10** [7], 512 (1931). M.V.K.

Surface tension of molten glass at temperatures near the melting point. W. B. PIETENPOL AND H. H. SCOTT. *Phys. Rev.*, **35**, 296 (1930).—The excess of pressure within a bubble of glass was balanced against a small head of liquid in a monometer. By this method measurements of surface tension of several glasses were made over a range of 200°C above the softening temperature. Surface tension of glass varies only slightly with temperature. The magnitude is of order 250 to 350 dynes per centimeter. D.E.S.

Double refracting nature of "Corex" glass. LORD RAYLEIGH. *Nature*, **126** [3187], 845 (1930).—The ultra-violet transmitting "Corex" glass of the Corning Glass Co. shows a doubly refracting structure which is not found in ordinary glasses consisting of silica with metallic oxides. Since "Corex" is said to consist mainly of calcium phosphate, further examination will be necessary. W.C.O.W.

Annealing optical and technical glass. K. STRUVE. *Ceramics & Glass*, **7** [9], 1–4 (1931).—Examples of calculating the annealing of different kinds of glass according to the methods of Adams and Williamson are given. M.V.K.

Acoustic properties of bottle glass. E. MEYER. *Sprechsaal*, **64** [47], 868 (1931).—The technical acoustic properties of bottle glass have an important part in building acoustics and room acoustics. For building acoustics, the transit of sound or insulation of sound is the important question. Glass is extensively used in the construction of partitions in offices besides the windows, and it presents important sound technical problems. Sound isolation is defined by the relation of the energy E_1 striking a wall to the energy E_2 given up by the wall in the form $10 \log_{10} E_1/E_2$ phone. Investigations on ordinary walls of different kinds of glass showed that the evenly defined sound isolation increases directly with the logarithm of the weight, and it is possible, therefore, to calculate the sound isolation of ordinary glass walls from the weight. If a double wall or double window with an air interval of 10 cm. is used, an increase in sound isolation of about 5 to 6 phones is obtained in contrast with an ordinary glass wall of the same weight of the wall. In room acoustics, the duration of the resonance is decisive for the capability of hearing; the time of resonance depending on the coefficient of absorption of the wall materials used. Masonry absorbs very little. Absorption materials such as curtains, felt, Cellotex, etc., have a higher coefficient of absorption. They absorb high tones especially well. Tests with glass showed that glass panes may likewise absorb well in consequence of their co-vibration. M.V.K.

Causes and prevention of explosions in silvering glass. JACQUES WOLF. *Glass Ind.*, **13** [1], 5–6 (1932).—After a short recapitulation of the actual process of silvering, the chemical principle involved is explained. The preparation and care of the various solutions used is discussed and the chemical changes produced during the silvering process are enumerated, pointing out wherein the danger of explosion occurs. A set of measures to be taken in order to avoid explosions is presented. See also *Ceram. Abs.*, **9** [1], 24 (1930). E.J.V.

Glass tile. ALEXANDER HOPKINS. *Glass Ind.*, **13** [1], 13–14 (1932).—The use of glass tile as a finish for walls, floors, and other parts of buildings and for decorative purposes has often proved unsatisfactory because of excessive breakage resulting when tile are closely confined at the edges and subjected to extreme temperature variations.

A new plastic cement that adheres permanently to both the glass tile and the background has been developed. The resiliency of the new cement provides for glass expansion and contraction. Some of the ways in which glass tile are superior to clay, marble, or enameled tile are discussed, as are many of the uses for them. Illustrated. E.J.V.

Manufacture of rolled plate. XVI. ERNST LUTZ. *Glass Ind.*, **13** [1], 6–11 (1932).—After a brief discussion of some of the patents dealing with the method of suspending and operating the polishing blocks, attention is given to the patents covering the systems of grinding and polishing which are developed on the continuous principle. The development of this principle by the Ford Motor Co., the Pittsburgh Plate Glass Co., and others is traced by discussing the claims of their various patents. Of fundamental importance for quick and economical grinding and polishing as well as a high-quality polish, is the work done in the laying shop. The glass sheets should be so set on the tables that the surface of the latter is utilized as completely as possible, that no sheet is set higher or lower than the others, and that the whole charge holds tightly to the table. Illustrated. For Part XV see *Ceram. Abs.*, **11** [2], 90 (1932). E.J.V.

Composition and use of household glass. G. KEPPELER. *Sprechsaal*, **64** [47], 867 (1931).—Household glasses vary in composition but a small lime content with a comparatively high content in silica and alkalis is characteristic of all of them. Part of the sodium is sometimes replaced by potash although never to the same extent as in polished glasses and especially in Bohemian crystal. Glasses containing potash are more easily melted; the silica content in such glasses may be increased without fear of devitrification. This is very important for glasses which are subjected to an additional heating. Household glass is shaped in blowing molds or machines. Both kinds of shaping have the same requirement for the quality of the glass, *i.e.*, that it not be too viscous at moderate temperatures and that it retain its capability of shaping over a high-temperature interval. This shows that household glass and pressed glass are similar and that glass factories can produce the same glass for different purposes. The chemical durability is not so important and consequently these glasses are rich in alkalis. Glass for preserves, although a household glass, must have a greater durability. The possibilities of using glass for insulating bottles and cooking utensils opens a new field to manufacturers of household glass, but further knowledge of the properties of glasses is necessary. M.V.K.

Safety glass. J. W. WILSON. *Pottery Gaz.*, **57** [655], 90–91 (1932).—The several methods now in vogue in the preparation of safety glass are briefly discussed. Tests suggested for the determination of the quality of safety glass are as follows: (1) *Impact test.* A ball weighing 1.68 lb. is dropped 10 ft. onto a glass measuring 14 x 12 in. and supported along two sides only. (2) *Boil test.* A good safety glass should stand 10 hours boiling without breakdown. This is to guarantee against premature blistering or bubbling in service. (3) *Edge breakdown.* The glass should stand 14 days' exposure to an atmosphere at 58 to 60°C and 90% humidity. (4) *Discoloration.* The glass should stand 80 hours' exposure to a quartz mercury vapor lamp at 55°C without serious discoloration. (5) *Bending strength.* A measure of bending strength will throw much light on the behavior of the glass under impact or torsion. (6) *Appearance.* The glass must be as free as possible from foreign matter or celluloid haze. E.J.V.

Window glass and ultra-violet rays. JACQUES WOLF. *Céram. Verrerie*, No. 829, pp. 381–82 (1931).—Ultra-violet rays are those rays having a wave-length of less than 400$\mu\mu$. The ultra-violet rays of the sun vary according to the time of day and the seasons. In winter, rays of less than 340$\mu\mu$ scarcely penetrate the atmosphere and consequently the skin does not tan even when exposed to bright sunlight. The ferric compounds in the glass absorb the ultra-violet rays more than any other ingredient in

the glass. The ferrous compounds absorb less. Usually less than 1% of the ultra-violet passes through ordinary window glass. W. gives tables showing the transparency of several glasses that are transparent to the short wave-lengths and notes that this transparency decreases to a constant value when these glasses are exposed to ultra-violet light for 20 hr. He discusses the growth of children when they are placed in rooms having windows of ultra-violet transmitting glasses and notes that the growth is more rapid and the hæmoglobin content of the blood is much greater than is found with a similar group of children who are placed in rooms having windows made of ordinary glass. The ultra-violet light causes the development of vitamin D in plants and he says that plants grown in green houses do not contain as much vitamin D and are not as good food as such plants grown out of doors. T.N.McV.

New light-source for absorption measurements of glasses in the blue and ultra-violet. WILLI M. COHN. *Jour. Amer. Ceram. Soc.*, **15** [2], 122–25 (1932).

Technical infra-red absorbing glasses. E. ZIMPELMANN. *Glastech. Ber.*, **9** [2], 102–108 (1931); *Diamant*, **53** [2], 17–18 (1931).—A review of the work done on infra-red absorbing glasses by various investigators and data on the properties of various technical products of this type are presented, showing the effects of the various ingredients used in the glass to bring about the desired characteristic of infra-red absorption. E.J.V.

Fused silica. BURROWS MOORE. *Pottery Gaz.*, **57** [655], 89–90 (1932).—In the discussion of the properties of fused silica it was pointed out that there are two types of products, (*a*) translucent and (*b*) transparent. The difference in the characteristics of the two is pointed out. The chemical resistance of fused silica is stressed and some detailed information regarding the following physical characteristics is given: (1) extremely small thermal expansion, (2) high melting point, (3) electrical resistance, (4) elasticity, (5) modulus of elasticity, (6) transparency to ultra-violet radiation, and (7) impermeability and low porosity. See also *Ceram. Abs.*, **10** [11], 766 (1931). E.J.V.

Yellow etching of glasses. I. WALTER HEINRICH. *Sprechsaal*, **64** [47], 868–72 (1931).—The results of preliminary tests are as follows: (1) The form of the silver salts contained by the etching paste has no marked effect on the color tone obtained. (2) The concentration of the silver salts in the etching paste is generally not decisive. (3) The use of a 1:1 paste is not advisable because it melts easily on the glass. (4) Admixtures of iron sulphide and ferrous oxide to the paste produce a deepening of the color. (5) The composition of the glass in per cent is not decisive for the color of the yellow etching. (6) Potash and soda do not act in a special way. (7) The assumption of Zsigmondy that ferrous oxide is the most active agent in the composition of glasses capable of being etched was not confirmed in the researches. (8) Colloidal carbon is distributed in the glass and probably sulphur also promotes a dark etching coloring in all cases. A technical utilization of this fact for the production of useful etched glass is, however, excluded because of the yellow coloring from carbon and sulphur in the glasses. (9) Common salt present in the batch has no influence on the color. (10) The cooling of the glass has no influence on the color. M.V.K.

Green bottle glass. ANON. *Ind. Silicati*, **9** [11], 12–13 (1931).—The chemical composition and properties of green bottle glass are discussed. A table shows the chemical composition of some well-known glasses. M.V.K.

Green glasses. ANON. *Diamant*, **52** [19], 307–308 (1930).—Some batches for the preparation of various green glasses are given. E.J.V.

Cracking of illuminating lenses. J. FLUEGGE. *Z. tech. Physik*, **12** [11*a*], 574–76 (1931).—Condensers used for projecting apparatus, etc., often crack when the illuminating lamp is shut off. Originally, this cracking was thought to be caused by too rapid cooling of the glass or inhomogeneities contained in it. New investigations have shown,

however, that cracking is caused by damaging the edge of the glass during the cooling process. Accordingly the edge of the lens is rounded off and then polished, thus avoiding cracking. W.M.C.

Modernization of the glass tank. ANON. *Amer. Glass Rev.*, **51** [8], 11–12 (1931).—The Amsler-Morton Co. has designed a glassmelting tank of the recuperative type with a patented air superheater for the Vitrometan glass factory in Siebenburg, Rumania. A cross-section illustration shows the design of heat exchanger used in the recuperator. The flues are arranged to convey air from the recuperator to the tank for combustion purposes and waste heat from the tank to the recuperator; in these the air is preheated to within a few hundred degrees Fahrenheit of the tank temperature. The waste gas, in giving off heat to the incoming combustion air, is greatly reduced in temperature prior to entering the recuperator and even though it may be laden with flux from the batch there is little or no corrosion of the tubes forming the recuperator. See also *Ceram. Abs.*, **10** [12], 834 (1931). E.P.R.

Insulation improves operation of glass tank. ANON. *Fuels & Fur.*, **9** [7], 852 (1931).—A glass tank in the plant of the W. S. Rawleigh Co., Freeport, Ill., is described. Insulating the sides and end walls of the regenerators and producer gas mains made a saving of 26.5% in fuel consumption. A.E.R.W.

Automatic regulators of glass tanks. V. FRIEDMANN. *Ceramics & Glass*, **7** [7–8], 6–12; [9], 11–22 (1931).—F. discusses the problems of automatic regulation of industrial furnaces and the requirements of regulators and describes different types of regulators used in German glassworks. M.V.K.

Automatic feeding of glassmelting tanks. F. H. ZSCHACKE. *Glashütte*, **61** [45], 824–27 (1931).—A description is given of different types of half automatic and automatic feeding installations used in Germany. M.V.K.

Slide-rule for estimating tonnage from automatic feeders. S. R. SCHOLES. *Glass Ind.*, **13** [1], 15 (1932).—As it is often desirable to estimate closely the quantity of glass drawn from a tank equipped with automatic machines supplied by flow-spouts or feeders, S. has designed a slide-rule to perform the arithmetical operation involved with one setting. Its manipulation is explained. Illustrated. E.J.V.

New devices used in glass manufacture in the U.S.S.R. E. C. GOUREVITCH. *Ceramics & Glass*, **7** [9], 8–11 (1931).—G. describes different new devices used in the manufacture of glass including a kiln for annealing glass objects, a press for manufacturing nonbreakable glass, and an apparatus for automatic glass cutting. M.V.K.

Inspection and testing of glassware. ANON. *Pottery Gaz.*, **57** [655], 97–98 (1932).—The two main reasons for testing glassware are (1) to prevent ware of inferior quality leaving the factory, and (2) to enable the effect of changes in the glass or in production to be estimated. Such topics as the necessity of suitable standards, extensive sampling, routine tests, the quenching test, the effect of crizzles, and anticipating troubles were discussed. E.J.V.

How to blow glass. ANON. *Christian Sci. Mon.*, **24** [7], 6 (1931).—A brief nontechnical discussion of the equipment and methods used in blowing glass is presented. E.J.V.

Glass painting revived. ANON. *Christian Sci. Mon.*, **24** [37], 9 (1932).—A Mass. artist, Edgar Curtis, has revived the old-time technique of glass painting, painting his pictures on the reverse side, backing them with tinsel to produce highlights, and then using a black background. Mirror painting is another field of art he has revived. Both arts are discussed briefly. E.J.V.

Glass industry in Germany and other countries. ANON. *Chim. & ind.*, **25** [6], 1569 (1931).—The German glass industry is concentrated in Saxony, Thuringia, the Rhein, and Westphalia. Natural siliceous sand containing up to 99.7% SiO_2, phonolite.

feldspar, retinite, and silex is used for the production of glass. Calcined sodium carbonate obtained from potassium by-products has a greater use than sodium sulphate. In 1928, Germany produced about 270,000 tons of Glauber salt of which 50,000 tons were used by the glass industry. Potassium carbonate produced in Germany is used for hollow glass. Most of the minium used for crystal lead glass is imported. Data on the glass production of Germany and other countries are given. M.V.K.

Exhibition of objects pertaining to the glass industry. ANON. *Glashütte*, **61** [48], 882–83 (1931).—Among the numerous objects and apparatus exhibited during the meeting of the German Glass Technical Society in Berlin were (1) crystal glasses and vessels colored by neodymium and praseodymium; (2) display bottles filled with rare earths and their salts, *i.e.*, cerium, lanthanum, didymium, neodymium, and praseodymium; (3) lead glass objects colored by neodymium and praseodymium and also in combination with gold; (4) sample melts with cerium and cerite salts and in combination with other coloring oxides; and (5) different glass objects in which rare earths were used as decolorizers. M.V.K.

Observations on the health of workers in Bavarian glass factories. KOELSCH AND LEDERER. *Gewerbepathol. Gewerbehyg.*, **1** [5], 656–86 (1931); *Chim. & ind.*, **25** [6], 1402 (1931).—Observations were made on 500 glass blowers and 500 workmen manufacturing flat glass. In the first case, young men were used exclusively, while in the second, 12.4% were over 50 years old. Infectious diseases were found mainly among the first class. In the second, there were many cases of bronchitis. The frequency of tuberculosis was the same in both classes; gastric, rheumatic, intestinal, renal, etc., disturbances were more frequent in the second group, as were also cuts. In the second group, there were many cases of deformed fingers and forearms. M.V.K.

Modern guidance of men in a plate-glass plant. F. VON VOPELIUS. *Glastech. Ber.*, **9** [2], 96–102 (1931); *Diamant*, **53** [2], 18–19 (1931).—The organization of workers in plate-glass plants in Saarbrücken, the training of workers for their specific duties in a special training course, and other modern innovations in plate-glass plant operation are discussed. E.J.V.

BOOKS

Seeing: A Partnership of Lighting and Vision. M. LUCKIESH AND F. K. MOSS. viii + 268 pp. Balliere, Tindall & Cox, London, 1931. Price 22s 6d. Reviewed in *Times Eng. Supp.*, **29**, 115 (1931); for abstract see *Ceram. Abs.*, **10** [4], 309 (1931). H.H.S.

Modern Glass. GUILLAUME JANNEAU. Published by William Edwin Rudge, New York. 184 pp. Price $12.00. Reviewed in *Ceram. Ind.*, **17** [5], 419–20 (1931); *Pottery Gas.*, **56** [654], 1635 (1931); see also *Ceram. Abs.*, **11** [1], 8 (1932).

PATENTS

Annealing articles of glassware. WALTER O. AMSLER. U. S. 1,837,311, Dec. 22, 1931. The method of annealing articles of glassware which consists in maintaining a solid body in heated condition, causing a stream of gas flowing in closed cycle to flow over the body, and causing the articles of glassware to advance through the stream.

Glassworking machine. VICTOR L. RONCI. U. S. 1,837,373, Dec. 22, 1931. A glassworking machine comprising a stationary base, a sub-base pivotally attached to the stationary base, a rotatable carrier on one end of the sub-base adapted to support a vitreous tubular member, a second rotatable carrier on the other end of the sub-base adapted to support a metallic cup member coaxially with respect to the tubular member, means for advancing the cup member into engagement with the tubular member, reciprocating-heater means fusing the rotating members together, and slidable means

extending into the tubular member to press the vitreous tubular member to the cup member.

Reinforced glass. JOSEPH H. LEWIS. U. S. 1,837,455, Dec. 22, 1931. A glass sheet having chromium-plated wire embedded therein.

Making plate glass. ALFRED L. HARRINGTON. U. S. 1,838,142, Dec. 29, 1931. Apparatus for making plate glass comprising a casting table, a pair of opposing sizing rolls above the table mounted for movement longitudinally thereof, a runway in advance of the table, a series of spaced rolls set into the top of the table with their peripheries projecting just above the upper surface of the table, means for supplying a cooling flow of air upward around the peripheries of such series of rolls, and driving means for causing the rolls to rotate after a sheet of glass has been deposited on the table to move the sheet off the table onto the runway.

Glassware-annealing leer. JOHN RALPH HOGE. U. S. 1,838,143, Dec. 29, 1931. In a glassware-annealing leer, the combination of an annealing chamber, means to carry ware through the chamber, a series of parallel shafts extending transversely of the direction of travel of the ware through the chamber above the ware-carrying means, baffle plates carried by the shafts, rack and pinion mechanism operable to simultaneously and uniformly vary the angular relation between the plates and conveyer, and means whereby each shaft may be rocked independently of the rack and pinion mechanism to change its angular relation to the other baffle plates and leer conveyer.

Glassware-forming machine. LEONARD D. SOUBIER. U. S. 1,838,161, Dec. 29, 1931. In a machine for heating and shaping glass blanks, a blank holder, means for causing the holder to engage a blank and hold it in an upright position, the holder including a pair of carriers pivoted to swing about a vertical axis, an annular series of jaw segments, and means forming a yieldable connection between the segments and the carriers whereby the segments yieldingly engage a blank supported in the holder, means to shape the end portions of a blank supported in the holder, the shaping means including a partible neck mold and an operating device movable back and forth and having operating connections with the neck mold and the holder, the device operable during a portion of its movement in one direction to open the neck mold without opening the holder and operable during its continued movement in the direction to actuate the holder and release the blank therefrom.

Producing tubular glass. LEONARD D. SOUBIER. U. S. 1,838,162, Dec. 29, 1931. The combination of a container for molten glass having a pair of bottom outlet openings positioned side by side near the center of the container, means to cause issue of glass through the openings in tubular form, and stirring implements rotating about the axes of the outlets, the paths of travel of the implements coinciding at points between the outlet openings.

Manufacture of sheet glass. RICHARD GENENGER. U. S. 1,838,305, Dec. 29, 1931. In an apparatus for making sheet glass, in combination, a pair of coöperating forming rolls, stands for these rolls, bearings in the stands for the journals of the rolls, means for adjusting the bearings of one roll relatively to the other for changing the distance between the rolls, traveling transporting tables for receiving the glass ribbon emerging from between the forming rolls, a motor for operating the roll-adjusting means, a clutch interposed between the motor and the roll-adjusting means, an electric circuit for controlling this clutch, a switch arranged to be actuated by the transporting tables for closing the circuit and rendering the clutch operative, and another switch adapted to be operated by the roll-adjusting means for opening the circuit and rendering the clutch inoperative.

Glass article. GEORGE L. HOCKENYOS. U. S. 1,838,309, Dec. 29, 1931. A glass vessel in which liquid is heated having a roughened interior surface.

Rolling plate glass. LAMBERT VON REIS. U. S. 1,838,337, Dec. 29, 1931. The

method of feeding glass to a forming pass between forming rolls which includes delivering molten glass to a receiver comprising the forming rolls and adjustable feed rolls located thereabove, and rotating the feed rolls while shifting them to reduce the capacity of the receiver to drive the molten glass to the forming rolls.

Glass-shaping machine. THOMAS COURTNEY MOORSHEAD. U. S. 1,838,435, Dec. 29, 1931. A glass-shaping machine comprising the combination of a frame rotatable about a central vertical support and having a plurality of blank molds, neck molds, and vertically movable register heads mounted thereon, a stationary cam track mounted on the support, supporting arms for the blank molds, means by which the cam track is caused to move the supporting arms with the blank molds thereon in a horizontal plane so that at times the blank molds are rotating in an outer circle to receive a charge of glass and at other times are rotating in an inner circle to coöperate with the neck molds, the neck molds being made in halves and housed within arms which are pivotally mounted on the undersides of the register heads, and means being provided for raising and lowering the register heads.

Glass furnace. THOMAS COLEMAN, JR. U. S. 1,838,530, Dec. 29, 1931. A continuous glass-tank furnace in which the glass has a substantially plane surface and moves longitudinally of the furnace toward the delivery end thereof, including a melting compartment, a refining compartment, a bridge wall between the two compartments, and a plurality of blocks at intervals in the floor of the melting compartment projecting upwardly beyond the floor level to obstruct or impede the longitudinal movement of the glass and thereby form inactive regions of glass.

Parallel resurfacing. AUGUST KADOW AND DAVID C. SMITH. U. S. 1,838,553, Dec. 29, 1931. In a machine for grinding and polishing sheet or plate glass, the combination of a work holder consisting of a thin sheet of flat material of less thickness than the work sheet, the work holder having a rectangular opening to receive a correspondingly shaped work piece, horizontally disposed stationary guides arranged to receive the edges of the work holder and hold the latter in a horizontal position, grinding plates above and below the work piece, a motor, driving connections between the motor and the plates for rotating them simultaneously in opposite directions for simultaneously grinding the upper and lower surfaces of the work piece, and automatic means operated by the motor for reciprocating the work holder and work piece during the grinding operation, the grinding surfaces being of sufficient extent and arranged to substantially cover the entire upper and lower surfaces of the work piece throughout the grinding operation.

Glass treatment. HAROLD R. MOULTON AND EDGAR D. TILLYER. U. S. 1,838,781, Dec. 29, 1931. (1) The process of making strengthened glass comprising placing between layers of glass a material having a higher coefficient of expansion, uniting the glass layers and material by heat, and cooling normally to place the glass under compression by contraction of the material thereon. (2) As a new article of manufacture, a glass plate having a member of material having a higher coefficient of expansion than the glass secured in the glass by heat, the member introducing a compressive strain in the glass upon cooling after the securing by heat due to the greater contraction of the member.

Leer-feeder attachment. IRA H. FREESE. U. S. 1,838,936, Dec. 29, 1931. A leer feeder including a cross conveyer, a stripper bar for moving ware from the cross-conveyer into a leer, and a replacing bar synchronized with the stripper bar and reciprocable in a path crossing that of the stripper bar.

Leer loader. ARTHUR COVEY. U. S. 1,839,375, Jan. 5, 1932. A leer loader including a tiltable and reciprocable rod, a stripper bar secured at one end to the rod and unsupported at its other end, means for reciprocating the rod, and means carried by the reciprocating means for intermittently tilting the rod.

Making glassware. CLYDE R. LOTT. U. S. 1,840,458, Jan. 12, 1932. That im-

provement in the art of glassworking which comprises the delivery of a downwardly moving stream of glass from a source of supply, the successive presentation of receptacles in the line of flow of the stream to receive the same, the successive separation of ends from the stream, the temporary application to the freshly produced ends of the stream, in the interval of shifting the receptacles from and to receiving position, of an upwardly moving gas stream in a state of combustion, and the withdrawal of the gaseous stream out of the path of the glass stream.

Annealing glassware. VERGIL MULHOLLAND. U. S. 1,840,463, Jan. 12, 1932. Apparatus for annealing glassware comprising a tunnel having an inner wall backed by material of higher heat-insulating characteristics than the inner wall, a plurality of longitudinally extending supporting members disposed within the tunnel, an endless openwork metallic conveyer for transporting articles of glassware through the tunnel while in direct contact therewith, the conveyer having the ware-bearing strand thereof slidably mounted on the supporting members and the idle strand thereof returning through the tunnel beneath the supporting members to become preheated through proximity with the ware, and means located adjacent to the receiving end of the tunnel and beneath the idle strand of the conveyer for heating the tunnel and for augmenting the preheating of the idle strand of the conveyer immediately prior to its active or ware-bearing travel through the tunnel.

Glassworking machine. PETER P. KUCERA. U. S. 1,840,513, Jan. 12, 1932. The combination in a glassworking machine having a plurality of operating stations, of a blank-carrying spindle for feeding a succession of blanks to the stations, a rotatable vacuum cup secured to each arm of the spindle for holding a blank therein, the cups having a beveled frictional face, rotating means at one of the stations intermittently engaging the face of each of the cups for producing rotation thereof, one of the operating stations including a burner, means simultaneously raising and lowering the burner into and out of burnishing relationship with a given blank and the rotating means into and out of frictional engagement with the vacuum cup holding the blank so that the blank will be rotated while being burnished by the burner, and means decreasing the intensity of the flame of the burner when the burner and the rotating means are lowered a short distance by the raising and lowering means so that the rotating means will still be in frictional engagement with the cup and the blank will be finished off, the raising means, after a short period of time, lowering the burner and the rotating means completely out of operative and burnishing relationship so that a new blank may be moved into position for burnishing.

Blown glassware. GEORGE E. ROWE. U. S. 1,840,532, Jan. 12, 1932. In a glassworking apparatus, a neck mold adapted to be rotated about its longitudinal axis and an open-ended annular guide at one end of the neck mold and in axial alignment therewith, the guide being adapted to receive a charge of molten glass and to direct part of the glass into the neck mold and being extended longitudinally for part of its circumference at the end thereof remote from the neck mold.

Controlling muffle leers. ALAN W. RUSSELL. U. S. 1,841,060, Jan. 12, 1932. In a tunnel leer for annealing glassware having a means for passing glass articles continuously through an elongate tunnel, a longitudinally extending temperature-controlling flue system associated with the tunnel, a plurality of spaced sets of passages communicating with the flue system for varying the volume of gases passing per unit of time through contiguous portions thereof, each set comprising independent passages communicating with the flue system at laterally spaced points, a compound damper mechanism associated with the sets for controlling the flow of gases along each of the passages, and a duplex control for the damper mechanism, one part of which controls simultaneously the flow of gases along each of the passages of a set and the other part of which controls

an additional flow of gases through the center passage of the set, whereby the temperature conditions transversely of the leer may be rendered uniform.

Manufacture of sheet glass by rolling. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 361,839, Dec. 9, 1931.

Glass bottles. FORSTER'S GLASS CO., LTD., AND W. FORSTER. Brit. 363,019, Dec. 23, 1931.

Manufacture of solid rods and tubes made of glass, etc. COMPAGNIE DES LAMPES. Brit. 363,267, Dec. 23, 1931.

Machines for working glass. CORNING GLASS WORKS. Brit. 363,276, Dec. 23, 1931.

Manufacture and production of rings or other hollow bodies of fused quartz. DEUTSCH-ENGLISCHE QUARZSCHMELZE GES. Brit. 363,610, Dec. 30, 1931.

Structural Clay Products

Ingredients to reduce the plasticity of clays and their use. ALBERTO PELLACINI. *Corriere Ceram.*, **10** [3], 97–99 (1929).—Thinning agents are siliceous sand, coal dust, ash, ground sandstone, saw dust, ground olive husks, and chamotte. They are used with very plastic clays to prevent deformation and cracking during drying. They lower the per cent of shrinkage and increase the porosity, thereby hastening the drying. More perfect products with more uniform coloring are obtained with a lower consumption of fuel. Noncalcareous sand with a melting point not lower than 1000° is the most economic thinning agent. Coal dust and saw dust are used only to obtain a porous solid brick which will not be subjected to great pressure. Tests must be made to determine the quantity of thinning agent to be used. M.V.K.

Weathering of structural clay products: A review. J. W. MCBURNEY. *Proc. A.S.T.M.*, **31** [Part II], 745–58 (1931).—This paper reviews briefly the present state of our knowledge of the weathering of structural clay products. The mechanism of weathering as produced by temperature change in the presence and absence of water, wetting and drying, percolation of water, crystallization of soluble salts, and the action of the atmosphere are considered. Among the tests for resistance to weathering considered are laboratory freezing and thawing, the sodium sulphate test, and the autoclave test. Some attention is given to the possibility of correlating certain measured properties of structural clay products with the results of laboratory freezings and thawings. R.A.H.

Weathering test procedures for clay products. H. D. FOSTER. *Proc. A.S.T.M.*, **31** [Part II], 795–98 (1931).—A study of weathering should involve not only a study of the action of freezing water within the pores of the material but also the chemical action of acids from the air, the erosion or abrasion of sharp wind-blown particles, the expansion or contraction due to climatic changes in temperature, etc. Well-fired clay products are highly resistant to the attack of acids that are normally present in the atmosphere. Moreover these products do not shrink and swell with changes in moisture content more than a negligible fraction of the amounts shown by concrete and some natural stones. The chief agents of weathering causing deterioration of clay products are undoubtedly frost action and the crystallization of salts in pores. Clay products in service are used under three weathering conditions, *i.e.*, underground, at the ground level, and in wall surfaces. Weathering requirements have been set down in various specifications, but for the most part are rarely used. H. discusses the freezing and thawing tests, moisture

absorption, and the test making use of destruction of the product by formation of crystals of sodium sulphate in the pores of the specimen. R.A.H.

Economic aspects of masonry decay from weathering. H. S. BRIGHTLY. *Proc. A.S.T.M.*, **31** [Part II], 716–24 (1931).—The purpose of this paper is primarily to point out the serious economic aspects of masonry decay and its generally preventable character, preventable except, of course, in the case of the use of decidedly inferior materials incapable of resisting exposure in the localities in which they are employed. A considerable portion of the paper is devoted to details of construction that are now employed or can be employed with various forms of material to prevent decay from weathering. Moisture penetration appears to be the main factor in considering the surface disintegration or decay of masonry materials, regardless of the exact source or character of this decay. In consequence of this, every means must be taken of preventing the penetration of moisture into the body of masonry from any source whatsoever, regardless of the character and durability of material employed. R.A.H.

Bibliography on the weathering of structural clay products. D. E. PARSONS. *Proc. A.S.T.M.*, **31** [Part II], 825–34 (1931).—A total of 63 titles of articles with a brief abstract of each is given covering the period 1885 to 1931. R.A.H.

Injury to plaster due to osmosis. F. L. BRADY. *Nature*, **126** [3183], 684 (1930).—Brick walls are sometimes found to which lime plaster cannot be made to adhere permanently. It is shown that when lime plaster is applied to brick containing a proportion of magnesium sulphate, a semipermeable membrane is precipitated on the face of the brick. As the plastered wall dries out magnesium sulphate is drawn from the body of the brick. It concentrates behind the membrane and then crystallizes, forcing the plaster and a thin shell of brick away from the wall. It was found possible to precipitate membranes of magnesium hydroxide in the walls of porous pots using a half-saturated solution of magnesium sulphate. Osmotic pressures as high as 100 cm. were developed in three days. W.C.O.W.

Efflorescence on brick and its cause. W. MARSCHNER. *Tonind.-Ztg.*, **55** [96], 1325–26 (1931).—Efflorescence on brick is caused mainly by sulphuric salts, whereas the chlorides and carbonates are found less frequently. The salts may be contained originally in the mortar or, if this is not the case, in the clay, in the grog, or in the water added to the clay before firing. Also, sulphur dioxide from the coal used for firing the brick may combine with the brick. The best means to prevent efflorescence is to fire the brick in a reducing atmosphere. In some cases the true efflorescence caused by salts is confused with mold caused by storing the brick in a damp, warm room. W.M.C.

Moistening fired clay products directly after removal from the furnace. MICHELE BAVARO. *Corriere Ceram.*, **10** [3], 103–105 (1929).—It is advantageous to moisten clay products directly after their removal from the furnace in the following cases: (1) Products containing lime and magnesia in fairly large particles are saturated with water directly after firing to help preserve them because it has been proved that lime drenched with much water swells less and does not produce the rupturing pressure produced with the slow absorption of moisture from the atmosphere. (2) The color can be restored to some clays which have become discolored during firing by moistening with water immediately after their removal from the furnace; in this case the water supplies the oxygen lacking in the iron oxide which was removed by the reducing fire. (3) Certain clays, especially alluvial clays, contain cementing elements and when moistened immediately after firing they undergo an internal cementation which heightens their cohesion and hardness. M.V.K.

Dry pressing in the manufacture of brick, tile, etc. MARCEL PINET. *Rev. mat. constr. trav. pub.*, No. 264, p. 164*B* (1931).—Dry pressing permits the use of the most plastic clays without the addition of nonplastics. It eliminates drying of the products,

and drying of the raw material is less difficult and is often achieved by using the heat from flue gases. It gives a remarkable density and makes possible the combination of extremely diverse materials. M.Y.H.

Production of paving brick by the dry-press process. J. Otis Everhart. *Jour. Amer. Ceram. Soc.*, **15** [2], 107–11 (1932).

Reinforced brick masonry. Hugo Filippi. *Clay-Worker*, **96** [6], 340–43 (1931).—A comprehensive review of the outstanding new developments in the field of reinforced brick masonry is presented. Illustrated. See also *Ceram. Abs.*, **10** [5], 349; [11], 779 (1931). E.J.V.

Use of hollow brick. O. Hartmann. *Tonind.-Ztg.*, **55** [101], 1404 (1931).—This is a discussion of the paper by Bangert (see *Ceram. Abs.*, **11** [2], 107 (1932)) giving more characteristic data for the use of hollow brick as a building material. W.M.C.

Improvement of the quality of vitrified brick. Anon. *Rev. mat. constr. trav. pub.*, No. 265, p. 184*B* (1931); for abstract see *Ceram. Abs.*, **9** [5], 349 (1930). M.Y.H.

Precast joint for connecting vitrified clay pipe. Anon. *Brick Clay Rec.*, **79** [10], 470 (1931).—The "slipseal" joint in the form of a ring is fitted into the bell and spigot of overlapping units of pipe. Experiments to date indicate that the joint is permanent, tight, and slightly flexible, sufficiently so to permit slight local settlements without danger of leaking. E.J.V.

Specifications for hollow masonry building units. Douglas E. Parsons. *Proc. A.S.T.M.*, **31** [Part II], 595–606 (1931).—From an analysis of published results of tests on large masonry specimens of clay hollow units, it was found that properties of the units not considered by current specifications had a marked influence on the compressive strength of the masonry. For end-construction masonry it appeared that the proportion of the gross sectional area of the masonry embedded in mortar was an important factor. In view of this it is suggested that specifications for hollow-masonry units should take account of the features of the design of the units likely to have an influence on the proportion of their sectional areas given a mortar bearing in masonry. The data pertaining to side-construction masonry indicate that the following geometrical properties of the units have an important effect on the strength of masonry and hence should be considered in formulating specifications: (1) ratio of thickness of horizontal-bearing shells to maximum span between vertical supports, and (2) features of design affecting the proportion given a bearing at bed joints. R.A.H.

New specifications for brick. Anon. *Tegel*, **21** [10], 78–81 (1931).—New specifications and standards for brick recently adopted by the Swedish Technologic Society are discussed. Dimensions of four standard shapes and classifications of six types of brick are given. Methods of sampling are specified. Definitions, procedure for determining, and specifications for each of the following are included: density, deviation in dimensions, warpage, compressive strength, and resistance to freezing. H.F.V.

Brick resembling marble. Anon. *Bldg. Supply News*, **42** [1], 38 (1932).—A new type of brick resembling marble in appearance is made by careful blending of certain clays and shales. E.C.C.

Relations between color and grain size of brick. K. Zimmermann. *Tonind.-Ztg.*, **55** [97], 1338–39 (1931).—A raw material containing calcium carbonate, *e.g.*, marl, should be ground sufficiently to prevent the formation of large pieces of calcium oxide which may crack the product. The color of a well-treated marl-containing brick was found to be almost as yellow as that of a chalk-containing brick when fired in the proper way. If the grain size of the marl is too great, the color of the brick will remain red. W.M.C.

Blue brick. W. Emery. *Rev. mat. constr. trav. pub.*, No. 265, p. 181*B* (1931); for abstract see *Ceram. Abs.*, **10** [11], 802 (1931). M.Y.H.

Green-colored brick. ANON. *Tonind.-Ztg.*, **55** [96], 1329–30 (1931).—This is a discussion of an article of the same title. See *Ceram. Abs.*, **11** [2], 107 (1932). W.M.C.

Brick road. F. WATTEBLED AND F. CARINI. *Rev. mat. constr. trav. pub.*, No. 264, pp. 176–79*B* (1931).—The following topics conclude a series of articles on tests for paving brick: (1) observations on loss by the rattler test; (2) effects of physical and chemical properties of the clay on the structure of the finished product, by R. C. Purdy, (3) permanent International Assn. of the Congress of Roads, 6th Congress, Washington, 1930, and (4) practical test at Koning and Brenfeldt, official laboratory at Amsterdam, Sept. 12, 1930. For previous articles see *Ceram. Abs.*, **10** [12], 841 (1931). M.Y.H.

Increasing output and reducing costs in brick works. COLIN PRESSWOOD. *Brit. Clayworker*, **40** [475], 303–305 (1931).—P. describes experiments to reduce the cost of brick made by wire-cutting and pressing and how drying was improved and hastened. Some notes are given on the study of kilns used for firing and on the improvement in the speed and effectiveness of firing. R.A.H.

Construction and management of small brick plants. O. PHILIPP. *Tonind.-Ztg.*, **55** [94], 1299–1301; [95], 1315–17 (1931).—The different points to be studied in connection with the construction and management of a small brick plant are outlined. Starting from the clay pit the handling and preparing of the raw materials is discussed as well as the forming, drying, and firing of the product. Different schematic sketches are given for brick plants operated only during the summer or throughout the year. Calculations for both types of plants are given. W.M.C.

Difficulties in brick plants. ANON. *Tonind.-Ztg.*, **55** [100], 1386–89 (1931).—Most of the difficulties occurring in brick plants are caused either by a wrong disposition of the plant or by a false handling of the equipment. Several samples are given for difficulties in drying and firing, and means of improvement are discussed. W.M.C.

Brick displays. ANON. *Clay-Worker*, **96** [6], 328–29 (1931).—Some of the brick displays on exhibit in the new Architects Building in Philadelphia are described. Illustrated. E.J.V.

Brick buildings of former centuries: Marienburg, Germany. ANON. *Tonind.-Ztg.*, **55** [96], 1328–29 (1931).—Some photographs are given of the famous Marienburg buildings and details of architecture are explained. W.M.C.

Uses of brick in the garden. KATHRINE MORRISON. *Christian Sci. Mon.*, **24** [3], 8 (1931).—Some examples, from England, of uses of brick for garden walls, pergolas, steps, terraces, paths, retaining walls, etc., are cited. The utilitarian and artistic purposes brick can serve are discussed. Illustrated. E.J.V.

PATENTS

Conduit. LLEWELLYN M. CHRISTIE. U. S. 1,837,759, Dec. 22, 1931. A set of related hollow conduit units adapted, when laid together, to form a conduit having a duct extending therethrough, the set being made up of two classes of units only, the first class comprising units whose end faces are substantially parallel, and the second class comprising units whose end faces are disposed at a predetermined angle to each other, such units being adapted to be disposed in interspersed relation to form a generally curved conduit portion the approximate radius of curvature of which may be varied by varying the ratio of the number of units of the first class to the number of units of the second class employed, whereby the need of special shapes for curves of particular approximate radii of curvature is obviated.

Making brick, etc. SYDNEY H. MARKLE. U. S. 1,839,324 Jan. 5, 1932. In a machine, a mold having a mouth at its top, a partition member in the mold horizontally movable to and from a position withdrawn therefrom, a filling member movable horizon-

tally above the mold, and connections operatingly intermediate the members for moving one of them with the movement of the other.

Dumping fork. WILLIAM J. SULLIVAN. U. S. 1,839,813, Jan. 5, 1932. A brick-handling fork comprising a frame and a plurality of fingers carried by the frame, the frame being pivoted adjacent to its top rear end.

Manufacture of brick, etc. THOMAS JONES, RICHARD BARKER, AND DUNCAN CAMPBELL MURRAY. U. S. 1,840,396, Jan. 12, 1932. Apparatus for treatment of soft brick-like goods before baking comprising means for supplying comminuted material to at least one surface of the goods, brushlike means, and means for displaying the brushlike means toward and away from the surface to indent the surface and to press the comminuted material into the material of the goods.

Molding bloated cellular blocks. KEMPER SLIDELL. U. S. 1,840,609, Jan. 12, 1932. The method of forming cellular blocks which consists in first preheating granular particles of earthy material to a point below fusion, next in heating a layer of the material within a mold to a temperature sufficient to cause fusion and bloating of the material occasioned by the liberation of gases and the formation of cells within the interior of the mass, and in slowly cooling and annealing the block so formed.

Making honeycomb brick. BENJAMIN A. SCHNEIDER. U. S. 1,841,215, Jan. 12, 1932. The method of forming a decorative surface upon an argillaceous body which consists in embedding particles of slag in the surface to be decorated and then firing the body to fuse the slag particles therein.

Manufacture of brick. H. NIELSEN. Brit. 362,102, Dec. 9, 1931.

Refractories

Researches on scorification of refractory materials. VI. Investigations on the power of corrosion and the constitution of smeltery slag. HERMANN SALMANG AND JOSEPH KALTENBACH. *Feuerfest*, **7** [11], 161–69 (1931).—(1) The action of free oxides and binary, ternary, and quarternary silicates on a homogeneous refractory (grog) was studied at 1320°, 1410°, and 1500°. (2) Smeltery slag may be traced back to a primary system, *e.g.*, the basic or neutral ferrous oxide silicate. Because iron is present in 2 degrees of oxidation, the ratio FeO / Fe_2O_3 was tested at slow and rapid cooling. No change in the degrees of oxidation of iron is produced by a difference in the method of cooling. (3) Free oxides have been arranged in decreasing succession with reference to their power of attack on grog; at 1400° Cu_2O, PbO, FeO, Sb_2O_5, Fe_2O_3, ZnO, and SnO_2 volatilize. (4) NiO, ZnO, PbO, and Cu_2O form silicates and their corroding action increases in binary melts in this order. Sb_2O_5 and SiO_2 formed no compounds but only glassy solutions. The slag attack is very small. SnO_2–SiO_2 melts and Cr_2O_3–SiO_2 melts could not be produced, while SnO_2 and Cr_2O_3 did not form any silicate. (5) Antimoniate of lead, copper, and nickel was produced. Antimoniate of lead has the greatest effect. The action of corrosion decreases with an increased Sb_2O_5 content. (6) Oxides were added in increasing quantity to the primary slag $2(FeO, Fe_2O_3)\cdot SiO_2$ and $(FeO, Fe_2O_3)\cdot SiO_2$. CaO obtained in per cents by weight proved to be the strongest base (this corresponds to former researches), while FeO has a weaker power of attack (in disagreement with former investigations). The following gives the corroding action of oxides in thoroughly melted slag, arranged in decreasing order and referred in per cents by weight:

CaO, Cu_2O, PbO, BaO, FeO, NiO, SnO	Al_2O_3, Fe_2O_3, Sb_2O_5, SiO_2, Ni_2O_3, ZnO, SnO_2, Cr_2O_3.

Oxides to the left of the line are bases; those to the right, acids. CaO is considered

as the strongest base; Cr_2O_3, as the strongest acid. When referring the succession in mol per cents, it is as follows:

PbO, Cu_2O, BaO, CaO, SnO, FeO, NiO	Ni_2O_3, Al_2O_3, SiO_2, Fe_2O_3, ZnO, Sb_2O_5, SnO_2, Cr_2O_3.

(7) Tin and nickel were investigated on their degree of oxidation in the melt. SnO proved to be a weak base; SnO_2, a strong acid. Ni_2O_3 was determined according to the equation: $Ni_2O_3 + 6HCl + 2KJ = 2NiCl_2 + 2KCl + 3H_2O + 2J$. The oxide was added to the primary slag 2PbO·SiO in the presence of NiO in order to determine the oxide. NiO and Ni_2O_3 are not much weaker than FeO and Fe_2O_3 as base strength and acid strength. The presence of Ni_2O_3 in slag is peculiar as it does not appear in hydrous solutions. (8) Tin oxide and aluminium oxide were tested on their amphoteric character. ZnO proved to be an acid in a basic slag and a base in a neutral slag. Al_2O_3 should be considered as a weak acid in neutral and basic slag. In cases in which a basic reaction of the alumina seems to exist, a conversion of the acid Fe_2O_3 into the basic FeO results through the presence of Al_2O_3; this conversion has been erroneously explained up till now as a basic reaction of Al_2O_3. For Part V see *Ceram. Abs.*, **10** [5], 353; [12], 845 (1931). M.V.K.

Development of some special refractories. H. E. WHITE. *Fuels & Fur.*, **9** [9], 1061–66 (1931).—"Special refractory" usually implies a material superior to the ordinary fireclay refractory. W. gives a nontechnical statement of the character and use of the several superior refractories. See following abstract. A.E.R.W.

Development of some special refractories. H. E. WHITE. *Fuels & Fur.*, **9** [10], 1155–62 (1931).—W. discusses the development of crystalline alumina refractories, mullite, high-purity magnesia, zircon, thermal insulation, and various applications of these refractories. Crystalline alumina refractories have a high thermal conductivity and thermal capacity and are used mainly for heat-treating and enameling furnace hearths. Synthetic mullite is prepared from a mixture of clays and bauxite or other aluminous material. High-purity magnesia refractories have been available only in recent years. They are selected for their resistance to slag action and are extremely useful in the new induction furnaces for manufacturing high melting-point alloy steel. Zircon is purified in the electric furnace by reducing the impurities by means of carbon. Zircon refractories have high mechanical strength under temperature. Diatomaceous earth can be used for refractory insulation at moderate temperatures but at extreme temperatures it is necessary to substitute higher refractory materials and obtain the insulation by artificial means such as adding pulverized wood products. Finely powdered material possesses higher thermal insulation than the bonded form. Special refractories have many applications, each of the types having its special use or uses. A.E.R.W.

New refractory raw material. GUSTAV KOPKA AND FRIEDRICH ZAPP. *Sprechsaal*, **64** [45], 827–28 (1931); for abstract see *Ceram. Abs.*, **10** [7], 506 (1931). M.V.K.

Manual for interpretation of refractory test data. ANON. *Proc. A.S.T.M.*, **30** [Part I], 478–504 (1930).—The desired effectiveness in the use of refractory tests in the control of manufacture, inspection, and utilization of refractories cannot be attained until all test procedures and methods of reporting data are put upon a sound statistical basis. The preparation of this manual was considered to be the first step in this direction. The procedures given have been based on well-established, modern statistical theory, and the symbols and definitions are those which are being adopted quite generally in work of this kind. Simple methods which are satisfactory for inspection purposes, and methods for establishing standards for materials which should be used for publication purposes are described. Under the heading, "How to analyze and report data," the following topics are discussed, (1) procedure, (2) arith-

metic mean, (3) average deviation, (4) physical significance, and (5) form of calculation and report. Tables are given to illustrate these points. Correlation coefficient defined mathematically may be used in predicting the value of one property when that of another is known. A discussion is given of sampling, problems, and general principles governing procedure. A list is shown of A.S.T.M. test methods, definitions, and specifications relating to refractories. G.R.S.

Use of bauxites for refractories. H. JORDT. *Tonind.-Ztg.*, **55** [99], 1377 (1931).—In a former paper (see *Ceram. Abs.*, **10** [5], 355 (1931)) J. discussed the possibilities of removing iron from bauxite. Since then, a bauxite deposit has been found in Dutch Guiana which contains 89% alumina and only 1 to 2% iron oxide; besides these, titanium dioxide and alkali are found in traces. The use of the new material for refractories is emphasized. W.M.C.

Bauxites. HANS JORDT. *Chem.-Ztg.*, **55** [22], 211 (1931); *Chim. & ind.*, **25** [6], 1425 (1931); for abstract see *Ceram. Abs.*, **10** [5], 355 (1931). M.V.K.

Foundry refractories. J. R. ALLAN. *Fuels & Fur.*, **9** [6], 669–70 (1931).—An abstract of a report presented to the American Foundrymen's Assn. is given. Experience indicates that brick joints must be protected with a clay or cement to prevent the penetration and progress of heat, flame, metal, and slag. A.E.R.W.

Corrosion of refractories, a quantitative durability test. J. F. HYSLOP AND H. C. BIGGS. *Colliery Guard.*, **143** [3701], 1913 (1931).—The primary object of a corrosion test is that it should give quantitative results indicating the durability of the material when exposed to slagging in service. It was desirable to have a test in which durability could be measured in definitely standard reproducible conditions, and at the same time have a test in which the effect of different fluxes could be accurately estimated. In a test devised for this, the test piece is rotated in a furnace and when the proper temperature is reached flux is fed by means of a water-cooled metal spoon at definite intervals. The time taken for the flux to sever the test piece in two is a direct measure of the durability of the refractory under the conditions of the test. E.J.V.

Refractories for boiler furnaces. W. J. REES. *World Power; Sci. et ind.*, **15** [209], 57 (1931); see also *Ceram. Abs.*, **10** [7], 505 (1931). M.V.K.

Refractory agglomerates and fused cement. ANON. *Rev. mat. constr. trav. pub.*, No. 265, p. 423 (1931).—Studies made by Kestner, Arnouldt, and Jaurrier in 1926 and Guiseppe Ongars in 1923 have given knowledge of mixtures that can be used like ordinary cement but without disintegration at high temperatures. The application of this process is varied and has been made with completely satisfactory results: (1) as refractory pieces of special kilns, pieces of high price and slow delivery, (2) repair of parts of refractory facings exposed to continued changes of temperature, (3) as a mortar for joining ordinary refractories in all furnaces, (4) for stopping cracks and to act as a protection against the destructive action of gas, etc., and (5) for application between refractory and metal parts. M.Y.H.

Kestner refractory hydraulic cements and mortars. I. J. ARNOULD. *Rev. mat. constr. trav. pub.*, No. 264, pp. 169–72*B* (1931).—This product is a true hydraulic, basic, and aluminous cement used with water like ordinary Portland cement. It is slow setting and rapid hardening, gives practically no shrinkage on setting, and gives a maximum of 1% shrinkage upon initial firing. **II.** *Ibid.*, No. 265, p. 419 (1931).—This cement combines the qualities of products of construction and refractories and can be used in a manner analogous to that of refractory masonry in kilns, gas generators, chimneys, etc. There are two types, one for low temperatures (below 1200°C), and the other for high temperatures (below 1400°C). The thermal conductivity of Kestner cement is close to that of bauxite. The melting point is 1300°C for the first type and 1400°C for the second. M.Y.H.

Lime production methods of Europe and America. VIII. Graduated linings for lime kilns. VICTOR J. AZBE. *Rock Prod.*, **34** [25], 35–39 (1931).—A. discusses the properties of lime-kiln refractories, using binary and ternary diagrams to show the fusing points of various compounds of lime, alumina, and silica. He brings out the advantages of a graduated lining made up of brick of different refractoriness, chemical composition, and insulating properties, according to the conditions in the kiln and gives a specific example of this. W.W.M.

The connection between the grading and porosity of silica brick. W. HUGILL AND W. J. REES. *Trans. Ceram. Soc.* [Eng.], **30** [10], 337 (1931).—Complete data are given for the relation between grain size, porosity, and density. The point of minimum porosity is 27.8%, at 46% 5 to 30 mesh, 18% 30 to 80 mesh, and 36% 80 mesh. C.G.H.

Silica brick made from chalk flints. W. HUGILL AND W. J. REES. *Trans. Ceram. Soc.* [Eng.], **30** [10], 342 (1931).—It is evident that lime-bonded silica brick made wholly from flint will invert completely to cristobalite with normal firing to cone 17, but will be of low mechanical strength. C.G.H.

Silica brick for coke ovens. P. B. ROBINSON. *Colliery Guard.*, **143** [3702], 1953–55 (1931).—This is a survey of the present position, in the light of practical experience, in regard to the use of silica or semisilica materials in the construction of coke ovens. Recent practical experience with silica-walled ovens has shown the following results: (1) The high thermal efficiency of the material effects an economy in fuel and provides an increased proportion of surplus gas for external use. (2) This fuel economy operates both at low- and high-flue temperatures. (3) Under ordinary conditions silica is more durable and more resistant to abrasion than semisilica and can be used with advantage in the whole length of the oven wall, including the door jambs. (4) With salty coal, silica is essential. (5) The application of high-flue temperatures accelerating the rate of carbonization is possible safely with silica-walled ovens. (6) With silica-walled ovens great elasticity of the temperatures is possible, permitting the successful use of coals of widely different coking properties. (7) It is possible to re-wall semisilica ovens with silica and gain in efficiency thereby without altering existing flue arrangements and without fear of damage to the sub-structure. (8) Satisfactory jointing material is available and can be depended upon to maintain gas-tight joints. (9) Expansion and spalling troubles can be avoided. E.J.V.

Influence of iron oxide on the rate of quartz inversion in lime and lime-clay bonded silica brick. W. HUGILL AND W. J. REES. *Trans. Ceram. Soc.* [Eng.], **30** [10], 321–29 (1931).—In lime and lime-clay bonded silica brick, the presence of 1 or 2% of iron oxide is a valuable constituent for inversion of quartz to tridymite. Brick composed of 1.5% Ca, 2.00% Fe_2O_3, and 2.50% china clay, all finely ground, contains only a small amount of unchanged quartz. When the matrix largely consists of interlocking tridymite crystals, the mechanical strength is high. By proper incorporation of iron oxide a near approximation to all tridymite brick may be obtained. See following abstract. C.G.H.

A further note on the influence of iron oxide on the rate of quartz inversion in lime and lime-clay bonded silica brick. H. W. HUGILL AND W. J. REES. *Trans. Ceram. Soc.* [Eng.], **30** [10], 330–36 (1931).—Thermal expansion studies reveal the fact that iron oxide hastens the quartz to tridymite inversion. The effect of the addition of iron scale to silica brick is to increase slightly the mechanical hot strength. Where china clay was incorporated in the mix, the load test gave a lower value, but brick bearing Fe_2O_3–CaO and clay were better than those of CaO and clay only. The observed greater durability in the acid open-hearth and electric furnaces of brick containing lime and iron scale is noteworthy. C.G.H.

Influence of titanium dioxide on the rate of quartz inversion in lime-bonded silica brick. W. HUGILL AND W. J. REES. *Trans. Ceram. Soc.* [Eng.], **30** [10], 347 (1931).—There is no evidence that titanium dioxide has any marked accelerating effect on the rate of quartz inversion. C.G.H.

Effect of firing at 1500°C on the porosity and specific gravity of quartzites. SANDFORD S. COLE. *Jour. Amer. Ceram. Soc.*, **15** [2], 87–95 (1932).

Physico-chemical properties of natural and artificial graphites. J. A. CHAPIRO AND VESSOLOVSKI. *Mineral. Suir'e*, **6** [3], 265–74 (1931); *Chim. & ind.*, **26** [5], 1131 (1931).—The electric conductivity and resistance to high temperatures of graphite has been studied. The electric conductivity depends on the structure of the sample, and to compare the results obtained powdered graphite was used and made homogeneous by sifting. The resistance of the powders of the different kinds of graphite previously compressed was determined. It was found that for each kind, the electric resistance is the same for the grain sizes from 0.10 to 0.27 mm. if the pressure of compression is 90 kg./sq. cm., but increases with finer powders. The resistance of different graphites diminishes progressively according to their crystallization. The more crystalline they are, the less is their resistance. The minimum is reached in the artificial graphite (electrode of Siemens). Measurements of the resistance to temperature were made on graphite powders in the presence of excess air. A slight decrease in weight can be observed at low temperatures; this decrease depends on the length of heating. The temperature at which a sample of powdered graphite loses 3% of its weight during 10 min. of heating was called "the temperature of attack." It was found that for a crystalline graphite like that of Ceylon or Madagascar, the temperature of attack is about 730°C, while graphite less crystalline has a slightly lower temperature of attack, and finally, for amorphous graphite, this temperature decreases to 535°. The losses increase with the temperature almost exponentially for the same graphites. M.V.K.

Study of the shrinkage of diaspore clays. II. STUART M. PHELPS. *Jour. Amer. Ceram. Soc.*, **15** [2], 96–106 (1932); for Part I see *Ceram. Abs.*, **6** [1], 20 (1927).

Elasticity and plastic softening of some sagger clays and porcelains. R. RIEKE AND G. MÜLLER. *Ber. deut. keram. Ges.*, **12** [9], 419–76 (1931).—Sagger clays were studied as to their elastic and permanent deflections at high temperatures. A definite distinction between high-alkali, low-alkali, and high-quartz materials was evident. It was assumed that the elasticity of a fired sagger has an effect on its stability. As a series of other factors also enter in, *e.g.*, the bending strength, the thermal expansion, the porosity, etc., which must be studied more closely for their influence, care must be taken in drawing conclusions regarding the stability from the elastic behavior. In regard to the elastic deflection and the plastic softening, a sagger will be insensitive to rapid cooling only as long as it remains in the temperature range of plastic softening, as no strains can be introduced then; an equalization can then occur in the yielding body. The elastic limit should be low. If saggers which must retain their form unchanged in firing are used, the danger of a permanent deformation with clays of a low elastic limit is great. In such a case it is more profitable to choose such clays whose plastic softening takes place at the highest possible temperature and which also have a high elastic limit. The danger of breakage, however, is much greater with such clays. Those sagger clays whose deflection and modulus of elasticity change the least with rising temperature will give the greatest security to the stability of the sagger bungs in the kiln. In this respect the Halle clay is superior. It is less important whether the total deflection and the elastic modulus is high or low to begin with than how it changes with the temperature. The slope of the curve for the total deflection in actual practice will not be as great as was obtained in the experiments conducted, as the load on the bottom sagger of a bung of 35 pieces will amount, at most, to 1.0 to 1.5 kg./sq. cm., while

in the experiments a load of 50 kg./sq. cm. had to be used from the nature of the measurement technique. Full details of the several clays and properties studied are given. Illustrated. E.J.V.

Life of the sagger as affected by varying certain properties. R. A. HEINDL AND L. E. MONG. Bur. Stand., *Jour. Research*, **7** [6], 1017–30 (1931); R.P. 387; for abstract see *Ceram. Abs.*, **11** [1], 43 (1932). R.A.H.

Open-hearth furnace regenerator brick. O. H. MELTER. *Blast Fur. Steel Plant*, **20** [1], 116–18 (1932).—The primary factor in manufacturing a regenerator brick is to have the lowest possible porosity. The dry-press method has done much to lower the porosity and to increase uniformity. A hard brick low in porosity accumulates less slag and cinder. Silica brick in regenerator chambers are necessitated by improper design of furnace ports and are really unsuitable for this service. Brick high in refractoriness, *e.g.*, the high-alumina class, are quite suitable for the top courses as far as serving in high temperatures is concerned. The proper placement of the brick should be given more thought as it is often possible to provide additional slag pocket space to prevent heavy particles of slag from carrying over into the regenerator flues. E.J.V.

"Carboradiant" furnaces. CHARLES MCMULLEN. *Blast Fur. Steel Plant*, **20** [1], 116 (1932).—The principle of the "Carboradiant" combustion chamber is explained and the advantages of its use are cited. The great advantage in its use lies in the fact that it gives uniform heat distribution throughout the furnace, together with practically perfect combustion over a wide range of firing rates. See also *Ceram. Abs.*, **10** [9], 655 (1931). E.J.V.

Comparative tests for determining resistance of fireclay brick to thermal spalling. R. A. HEINDL. *Proc. A.S.T.M.*, **31** [Part II], 703–14 (1931).—Specimens of 23 brands of fireclay brick representing a fairly wide geographical distribution were furnished for these tests by twelve manufacturers of refractory products. The methods of manufacture included the semidry press, the stiff-mud extruded, and the handmade. The brick were tested for resistance to thermal spalling in accordance with (1) the standard method of testing promulgated by the Federal Specifications Board, (2) that prescribed by the A.S.T.M., and (3) according to four methods which were modifications of these two standards. The results show that when the brick are tested by the method given in the Federal specifications, those manufactured by the semidry-press process are decidedly superior in resisting failure while those manufactured by the stiff-mud process show the least resistance. When using the A.S.T.M. method the brick manufactured by the handmade process show the greatest resistance to failure with no significant difference between those manufactured by the semidry-press and stiff-mud processes. The percentage mean deviation from the average in the number of cycles required to cause spalling is practically the same in the present tests. The percentage loss is decidedly greater in the A.S.T.M. method of test than in any of the other methods. The requirements of the method of testing, however, account for the greater loss. R.A.H.

Drawing up standards for the testing of the probable behavior of tank blocks. W. MIEHR. *Glastech. Ber.*, **9** [1], 14–22 (1931); for abstract see *Ceram. Abs.*, **10** [8], 576 (1931). E.J.V.

Furnace walls. V. GEORGE P. REINTJES. *Blast Fur. Steel Plant*, **19** [12], 1598 (1931).—Brick which formerly weighed 5 lb. now weigh 6 lb. A trowel of cement mortar used now will spread for only four brick, whereas formerly with an equal weight of lime mortar it spread for seven brick. Thinner walls enable more laying to a line and brick walls are now $18^1/_2$ brick per cu. ft. compared with $22^1/_2$ brick per cu. ft. With increased furnace volume (1) more refractories are required due to increased temperatures, (2)

additional strains are put on the hot brick due to higher walls, (3) leakage of excess air is increased, and (4) expansion and shrinkage is also increased. Two designs for walls were made to (1) reduce radiation losses, and (2) to cool the refractories by increasing the radiation loss. **VI.** *Ibid.*, **20** [1], 118–20 (1932).—As the result of observations on the early furnace walls it became apparent that some form of insulation would save some of the heat lost by radiation. The insulation, however, could not be placed too close to the surface of the furnace lining as the temperature and fluxing elements in the fuel penetrated the wall much deeper. When fuels are used that have a high sulphur or iron content, the brick are cooled to a point below that at which a chemical combination between the fluxed ash and brick would occur. This is accomplished by several different types of air-cooled walls which have been developed. The methods whereby the air is circulated in the walls are enumerated and discussed. A comparison is made of the amount of B.t.u. lost at various operating temperatures through different thicknesses of wall. Illustrated. For Parts III and IV see *Ceram. Abs.*, **11** [1], 39 (1932). E.J.V.

Heat insulators for temperatures reaching 1350°. I. S. KAMMERER. *Feuerung*, **7** [1], 1–3 (1931); *Chim. & ind.*, **25** [6], 1387 (1931).—Kieselguhr was for a long time the only insulating industrial material. It has different degrees of porosity but it softens at about 950° in spite of its origin and treatment. New heat-insulating materials have recently appeared. They are of German and American origin and can withstand up to 1350° and even 1400° and 1500° depending on the pressure to which they are subjected. The most interesting products are "Sil-O-Cel" and "Superdia." A comparison between these two substances and kieselguhr shows that the latter has a lower calorific conductivity than the two former, but is much less resistant to very high temperatures. When pressure is exerted perpendicularly to the direction of flow of heat, products such as Sil-O-Cel and Superdia can stand a temperature of 1350° on account of the rapid fall in temperature (5° per min.). When the pressure is exerted parallel to the direction of flow of heat, the maximum temperature which the product withstands does not exceed 1200 to 1250°. M.V.K.

Study of apparatus for cutting brick, etc. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 265, pp. 189–93*B* (1931).—The preparation of clays before pugging and their grinding and screening is described. Broken saggers are used in the preparation of grog, large pieces for the making of refractory products and smaller ones for the making of cement for mending saggers. See also *Ceram. Abs.*, **11** [1], 47 (1932) and this issue p. 192. M.Y.H.

Kiln plate design changed. NORTON CO. *Ceram. Ind.*, **18** [1], 56–58 (1932).—The Norton Co., Worcester, Mass., has developed a new Crystolon bat or kiln plate. It is of silicon carbide and the edges are slotted to minimize breakage. Other advantages are given. W.W.M.

Development of refractories in 1931. O. H. F. BUILDER. *Blast Fur. Steel Plant*, **20** [1], 59–60 (1932).—More uniform clay and silica brick as to firing and size, as well as 9-in. straights 3 in. in thickness instead of $2^1/_2$ in., have been developed. Chrome brick of a coarser grain size with an improved bond and heat treated in tunnel kilns give considerably longer service in the furnace. Magnesite brick pressed in high-powered hydraulic presses and used without kiln treatment produce an electrically sintered magnesite product having a softening point above 3000°F and a melting point close to 5000°F. Good high-alumina brick, mullite and sillimanite brick, and lower-priced plastic refractories for use in steel mills are all developments of 1931. The salvage of brick bats from dismantled furnaces is now more generally undertaken. Tests of refractories are now made by both the producer and consumer in order to obtain check results and help in the improvement of the product. E.J.V.

BULLETIN

Thermal shock effect on the transverse strength of clay bodies. W. R. MORGAN. Univ. of Ill., *Eng. Expt. Sta. Bull.*, No. 229, 30 pp. (1931); *Amer. Glass Rev.*, **50** [40], 32 (1931); see also *Ceram. Abs.*, **11** [1], 37 (1932).

PATENTS

Refractory shapes. ELMER O. BEARDSLEY AND WALTER F. PIPER. U. S. 1,838,522, Dec. 29, 1931. That improvement in making refractory shapes which consists in slinging into a mold small wads of refractory shape-forming material in rapid succession and with sufficient speed to pack the material in the mold so that it is of uniform density and distributed evenly throughout the entire mold.

Refractory insulator support for electron-discharge devices. CHARLES V. IREDELL. U. S. 1,838,766, Dec. 29, 1931. An insulating support comprised of aluminum oxide approximately 98% and talc 2%.

Hollow earthenware articles. ALBERT CHARLES MAY. U. S. 1,839,110, Dec. 29, 1931. A device for the manufacture of hollow articles of a refractory nature comprising a mold having a closed bottom and adapted to be rotated about a central vertical axis, means for feeding a dry-powdered material and a fluid to the mold and adapted to be supported to extend downwardly into the mold substantially coaxially of the latter, and a shaping tool adapted also to be inserted into the mold to press the material deposited therein firmly against the inner surface thereof, the tool being supported freely to rotate about a vertical axis.

Refractory product. WILLIAM J. MCCAUGHEY. U. S. 1,839,982, Jan. 5, 1932. A method of making a refractory material for furnace linings, etc., which comprises intermixing magnesium limestone and glauconite and firing the mixture at a high heat to a clinkered granular product.

Brick and brickwork for hot blast stoves, etc. AUGUSTUS E. ANDERSON. U. S. 1,840,554, Jan. 12, 1932. Brickwork for hot blast stoves, etc., composed of L-shaped brick arranged in superposed horizontal courses, with the legs and bases of the brick disposed in horizontal planes, and with the legs of superposed brick in the same vertical plane, but with the bases of the brick in adjacent horizontal courses projecting in opposite direction.

Manufacture of refractory ceramic ware. E. LUX. Brit. 361,858, Dec. 9, 1931.

Surfacing refractory bodies. DOHERTY RESEARCH CO. Brit. 361,964, Dec. 9, 1931.

Production of alumina from alkaline earth aluminates. LONZA ELEKTRIZITÄTSWERKE UND CHEMISCHE FABRIKEN AKT.-GES. Brit. 363,612, Dec. 30, 1931.

Terra Cotta

Night architecture. M. BARRETT. *Trans. Ceram. Soc.* [Eng.], **30** [9], 308 (1931).—B. discusses the requirements of constructional materials to render them suitable for floodlighting. Initial reflection factors are as follows: (1) white terra cotta, cream terra cotta, and light marble, 60 to 80%; (2) light gray limestone, buff limestone, and buff building brick, 40 to 60%; (3) sandstone, gray brick, medium gray limestone, and tan colored brick, 20 to 40%; (4) red brick, brown stone, and dark gray brick, 10 to 20%. Any material must have a reflection factor of greater than 20% to be economically floodlighted, unless the dressings are of a lighter color. In addition to the color value, the texture is also of prime importance. Cleanliness is a necessary consideration. Various common types of floodlighting are discussed. C.G.H.

Metallized terra cotta. M. BARRETT. *Trans. Ceram. Soc.* [Eng.], **30** [10], 315 (1931); for abstract see *Ceram. Abs.*, **10** [11], 786 (1931). C.G.H.

Manufacture of terra cotta. L. D. FETTEROLF. *Fuels & Fur.*, **9** [8], 957–59 (1931).—F. gives a nontechnical description of terra cotta and its manufacturing process. A.E.R.W.

Glazed ware developing rapidly. ANON. *Brick Clay Rec.*, **79** [10], 480–81 (1931).—The manufacture of glazed ware as a definite branch of the clay-products industry is rapidly taking form. Because of their colorful appearance and impervious, washable face, they are used particularly for building interiors. Several methods of glazing are available which include the newest developments, *e.g.*, automatic spraying and dry spraying of brick columns. Illustrated. E.J.V.

Management of terra cotta plants. F. THEILMANN. *Tonind.-Ztg.*, **55** [98], 1356–58 (1931).—Some forms are given for use in the management of terra cotta plants. W.M.C.

White Ware

Dielectric strength of porcelain: the influence of firing temperature. A. J. MONACK, L. R. SHARDLOW, AND D. H. WAMSLEY. *Jour. Amer. Ceram. Soc.*, **15** [2], 126–29 (1932).

Durability of ordinary porcelain colors in washing machines and in the laboratory. H. KOHL. *Sprechsaal*, **64** [48], 887–90; [49], 907–908 (1931).—Comparison tests show that a combination of testing methods is necessary to reproduce conditions in practice to determine the durability of porcelain colors in washing machines. This is especially true for violet colors which are attacked in the washing machine supposedly by soda, but which do not change even after boiling with 1% soda solution in the laboratory tests. It can be assumed, therefore, that other elements are present in the washing machine besides alkaline washing agents which act on the decorations on porcelain like that of HCl in laboratory tests. This can be explained either by the mechanical action of water jets or by the weak organic acids from the traces of food which gradually concentrate in the washing solution and are not immediately neutralized. It is necessary, therefore, that the colors be treated with both HCl and soda solutions in laboratory tests. The test of the 5-hr. action of a 3% HCl solution at room temperature and boiling with 1% soda solution for 30 min. is sufficient. Colors which will withstand these tests will be sufficiently acid-proof and alkali-proof in practice. It is pointed out that (1) the washing agent "Imi" used in tests did not affect even delicate color tones; (2) the present ceramic pigments are stable; and (3) of the 291 colors investigated, a large number of sensitive colors are used only in art and luxury porcelain. Several tables in colors illustrate the article. See also *Ceram. Abs.*, **10** [8], 582 (1931). M.V.K.

Refractory porcelain. A. H. FESSLER. *Fuels & Fur.*, **9** [10], 1193–96 (1931).—Refractory porcelain is used where resistance to combined high temperatures, acids, fluxes, and combustion gases is necessary and where all other such deleterious factors are encountered. The resistance of all refractory porcelain to thermal shock is of great importance. It is also necessary that the coefficient of thermal expansion be low. Refractory porcelain is usually of higher mechanical strength than low-fired porcelain. It should be sufficiently refractory at the temperature at which it is used and should be impervious at all temperatures. The electrical properties of refractory porcelain are of special importance in the selection of porcelain for spark-plug insulators. The glaze used must not soften while in use and it must fit the porcelain body. High thermal conductivity is a desirable property for most uses. A.E.R.W.

A nonsiliceous porcelain with a pure fluorite base. A. DAMIENS. *Compt. rend.*, **20** [192], 1235–37 (1931); *Chim. & ind.*, **26** [5], 1126 (1931); *Sprechsaal*, **64** [48], 894 (1931).—Investigations on fluorine and its compounds have been difficult or even impossible because of their corroding action on crucibles of silica, silicates, glasses, porcelain, and even platinum over 400°. Fluorite is the only substance unaffected by fluorine and its compounds but it could not be used because of its tendency to break into small fragments on heating. D. succeeded in preparing pieces of fluorite of different shapes, *e.g.*, tubes, crucibles, etc., which are water tight and resist sudden temperature changes. They were fired in saggers to 1250° or 1300° and protected from gases of combustion. These objects are made from a mixture of 25% of colloidal calcium fluoride artificially prepared by precipitating potassium fluoride with $CaCl_2$ into a dilute solution and 75% powdered crystallized natural fluorite (120-mesh sieve). The use of artificial and colloidal fluorspar produces a paste of a sufficient plasticity for shaping and permits the soldering of different pieces by binding them with a coat of the original plastic paste. This method of agglomeration is susceptible to generalization. M.V.K.

Composition of porcelain masses. A. I. BRAUN. *Ceramics & Glass*, **7** [9], 36–38 (1931).—B. discusses the composition of different porcelain masses used in Russia and points out the necessity of their exact calculation based on the mineralogical and chemical structure. M.V.K.

Manufacture of large complex porcelain insulators. O. NAUMANN. *Mitt. Hernsdorf-Schomburg-Isolatoren G.m.b.H.*, **55**, 1729–64 (1930); *Ceramics & Glass*, **7** [9], 61–63 (1931).—The method of manufacture is described in detail. M.V.K.

Manufacture of porcelain and faience in the U.S. and Germany. I. A. B. BERKMAN. *Ceramics & Glass*, **7** [9], 23–36 (1931).—B. discusses the technique of the manufacture of all kinds of porcelain and faience in America and Germany. The raw materials used and all the processes of production are described in detail. M.V.K.

Influence of shaping on the quality of porcelain. M. W. FLEROV. *Ceramics & Glass*, **7** [9], 39–42 (1931).—F. discusses the results of studies on the changes in the homogeneity of porcelain masses during working up and shaping. During shaping, the particles of that part of the mass which is worked with a pattern are loosened and acquire a different water absorption and shrinkage. These processes produce internal strains reducing the thermal resistance and mechanical stability of the ware. M.V.K.

Relation of soda-lime ratio to the blending of feldspars. C. R. AMBERG. *Jour. Amer. Ceram. Soc.*, **15** [2], 140–43 (1932).

Proposed method for feldspar fusion trials. H. B. DUBOIS. *Jour. Amer. Ceram. Soc.*, **15** [2], 144–48 (1932).

Softening of feldspar glass and the influence of different additions thereon. R. RIEKE AND LISELOTTE MAUVE. *Ber. deut. keram. Ges.*, **12** [8], 379–400 (1931).—Melts of a potash feldspar and a soda feldspar were made in a porcelain kiln. Melts of potash feldspar with 10 to 60% additions of quartz and 3 to 10% additions of alumina as well as with 2% additions of CaO, BaO, MgO, or ZnO were also made in the same way. The soda feldspar was melted with 2% additions of CaO, BaO, MgO, or ZnO only. Small cylinders of the finely powdered melts resulting from this treatment were pressed and heated in an electric furnace to complete vitrification. These bodies were heated under constant load at different temperatures between 900° and 1200° and the speed of their compression was measured to determine their softening conduct. From these data the viscosities were determined approximately. As preliminary results the following were discovered: The relation of viscosity of molten potash feldspar to the temperature is approximately a logarithmic function between 1000°C and 1200°C. The lowering of viscosity is proportionately slow and it is concluded from the course of the curves that the melt is still very viscous at high temperatures. An addition of silica

increases the viscosity and this effect increases with increasing SiO_2 content, while the temperature relationship approaches the same as with pure feldspar. The decrease of viscosity with increasing temperature with an increase of SiO_2 content appears to be somewhat lower. The effect of alumina cannot be clearly determined as no clear melts were obtained It appears, however, that the effect is different according to the amount of alumina added, inasmuch as small amounts lower the viscosity somewhat and larger amounts increase it. For the effect of small additions of CaO, BaO, MgO, and ZnO some oriented experiments were made from which the viscosity lowering effect of lime is most evident as it works more strongly than the same amount of the other additions used. A very low potash soda feldspar exhibits a fundamentally different behavior than soda feldspar. The decrease in viscosity with increasing temperature takes place much more rapidly with it. While at 1100°C it is considerably more viscous than potash feldspar, at 1200°C its viscosity attains an intrinsically lower value. A similar behavior is also observed in melts of soda feldspar with 2% CaO, BaO, MgO, or ZnO. Indeed, in contrast to potash feldspar, the viscosity is increased the most by these additions. It is assumed that in soda feldspar melts crystalline separation occurs, strongly influencing the behavior. These relations will be clarified by further experiments. E.J.V.

Feldspar and its uses. II. F. P. KNIGHT. *Ceram. Ind.*, **18** [1], 33 (1932).—K. states that more educational research on feldspar is needed. Not enough attention is paid to the exact composition of the feldspar when the effects of different amounts of it on the body are being determined. Knowledge necessary to give real value to feldspar tests is given by K. This includes chemical and mineralogical composition and geological history. For Part I see *Ceram. Abs.*, **11** [2], 132 (1932). W.W.M.

Development of fine ceramics in 1930. E. KELLER. *Ceramics & Glass*, **7** [9], 43–47 (1931).—K. describes the achievements in the manufacture of fine ceramics for 1930 and discusses (1) raw materials, *e.g.*, kaolin, clay, feldspar, quartz, sand, and gypsum, (2) preparation and shaping of masses, (3) drying and drying installations, (4) firing and firing kilns, (5) methods of investigation, testing materials, and control of production, *i.e.*, chemical, rational, and mechanical analyses, (6) rational production and standard specifications, (7) glazes, (8) ornamentation, and (9) separate products such as stoneware, saggers, faience, and porcelain. M.V.K.

Resistance to microbial invasion shown by high-fired ceramic products used for flagging the ground floors of habitations. F. CHALAMEL. *Céramique*, **34** [518], 102–106 (1931).—After pointing out the dangers of a floor which will not resist surface pollution or invasion by bacteria, C. describes experiments in which the resistance to such infection was determined for a number of products used for floors in houses. The least porous, most stable, longest wearing material that was least subject to deterioration of the joints or formation of cracks would be expected to have the most resistance. Stoneware gave practically complete protection; earthenware of good quality was subject to a slight penetration and pollution; cement tile themselves were little subject to infection but their pores and deteriorated joints made favorable localities for microbe development; monolithic floors lost their initial resistance by the formation of cracks and wooden floors showed marked penetration and pollution. Only the stoneware floors could be washed and dried readily without leaving an unsanitary dampness. Waxing gave protection against penetration but encouraged surface pollution. C. lists the products in the order of their resistance to infection as follows: (1) stoneware (the only truly sanitary), (2) earthenware of good quality, (3) cement blocks, (4) monolithic floors, and (5) wood floors (especially subject to infection). A.E.R.W.

Trial for testing clay bodies and body materials on a laboratory scale. GEORGE A. WILLS. *Jour. Amer. Ceram. Soc.*, **15** [2], 135–39 (1932).

Notes on casting slip in production. GEORGE A. WILLS. *Jour. Amer. Ceram. Soc.*, **15** [2], 130–34 (1932).

Casting properties of a slip. N. N. NISHEGORODOV AND S. A. RABINOVICH. *Ceramics & Glass*, **7** [9], 47–50 (1931).—(1) An insufficient or excess moisture content in the slip produces many defects in the ware. (2) The size of the ground particles of the slip has a great influence on its casting properties. Different methods of controlling the casting properties of a slip are discussed. M.V.K.

Developments in the electrical industry in glass, enamel, and pottery. HOBART M. KRANER. *Ceram. Ind.*, **18** [1], 12–13 (1932).—An interesting review is given of the progress made in equipment and ceramic products which are used in the electrical industry. W.W.M.

Dust problems in potteries. ANON. *Times Eng. Supp.*, **29**, 107 (1931).—The English National Council of the Pottery Industry is holding conferences to consider means of overcoming dust. Fettling of ware in the green state is one method. The bag dust filter, one design of which claims 100% efficiency, is also discussed. H.H.S.

PATENTS

Plumbing fixture. WILLIAM E. SLOAN. U. S. 1,838,198, Dec. 29, 1931. A plumbing fixture comprising a bowl, an upstanding water chamber at the rear thereof, means for connecting the chamber with a source of water supply, a connection between the chamber and the bowl through which water flows to flush the bowl, and a discharge device for the chamber through which water passes to the bowl, the discharge device being constantly open, being located above the water line of the bowl and in communication with the atmosphere on the exterior of the bowl when the bowl is completely filled, and acting to conduct water from the chamber when the bowl is flushed and air back into the chamber after the flush has been completed to prevent back flow from the bowl into the supply pipe.

Moistening ceramic articles while shaping them. JEAN MARIE ANDRÉ FAURE. U. S. 1,839,750, Jan. 5, 1932. Apparatus for moistening the paste during the shaping of ceramic articles comprising a revolving tool adapted to shape an article on a fixed mold, a tool holder, and an atomizer on the head of the tool holder.

Underglaze decorating print ware. FRANK AULT. U. S. 1,840,008, Jan. 5, 1932. Apparatus for transferring printed decorations to pottery ware including a frame, a brush rotatively mounted on the frame and having its bristles shaped to fit the contour of the ware to be decorated, means for rotating the brush, a shaft axially aligned with the brush and having a rack portion thereon, a table fixed on the shaft and normally spaced from the brush, a pinion meshing with the rack portion of the shaft, and lever means for rotating the pinion to axially move the table toward the brush.

Altering the physical properties of finely divided mineral substances. RUDOLF ILLNER AND CAMILLO FÜRST. U. S. 1,840,363, Jan. 12, 1932. A process for altering the physical properties of kaolin which consists in first coagulating crude kaolin with milk of lime, then neutralizing the same with sulphuric acid of 60° Bé, adding powdered sodium hydrosulphite in the proportion of about 1 part to 1000 parts of dry kaolin present with about 2 parts of sulphuric acid of 60° Bé while stirring the mixture for 30 to 60 min.; thereupon neutralizing the mixture with milk of lime having an excess of 1 part of quicklime to 1000 parts of dry kaolin, again stirring the mixture for about the same length of time, then adding 0.025 to 0.05% of coloring matter, again stirring the mixture, and finally pressing and drying it.

Electric high-tension lead-in insulator. PORZELLANFABRIK P. ROSENTHAL & CO. AKT.-GES. Brit. 361,852, Dec. 9, 1931.

Equipment and Apparatus

Science and practice of drying. VIII. ANON. *Brit. Clayworker*, **40** [475], 278–81 (1931).—Perkin's high hot-pressure heating system, patented in 1840, is much superior in convenience and efficiency in sheds or buildings for drying clayware where waste heat is not or is only partially available. It is simple to install and flexible in application. The system is described in detail. Driers over continuous kilns are briefly discussed as well as Zehner's changing stream system which is claimed to dry 40% more brick than are fired in the kiln. The heat yielded by the kiln is used in three phases in this system: (1) radiation of the brickwork and arising from kiln chambers in the final stage of cooling, (2) heat direct from the cooling chambers, and (3) heat direct from combustion gases. **IX.** *Ibid.*, **40** [476], 312–14 (1931).—Waste heat calculations are given showing the number of B.t.u. necessary to evaporate water from the ware, air to carry it off, and size of flues and speed of air or draft travel to accomplish satisfactory drying. Under the perfected conditions attained at the present time by means of the labor-saving appliances used in the modern drying plant, the drying of brick in the kiln chambers should be ruled out as uneconomic as well as technically inefficient. The semidry process of manufacture of brick combined with tunnel-kiln firing is the most labor-saving combination known. Controlling devices for supplementary waste heat in drying sheds, waste heat from continuous kilns in drying sheds, and the Martin-Lancaster drier are also discussed. For Part VII see *Ceram. Abs.*, **11** [1], 47 (1932). R.A.H.

Artificial brick drying. P. THOR. *Tonind.-Ztg.*, **55** [96], 1323–25; [97], 1341–42 (1931).—Some problems relating to the artificial drying of brick are discussed, *e.g.*, the best way to guide the air in the drying chambers, drying by using a combination between air and flue gases, and the possibility of increasing the output of existing drying plants. Illustrated. See also *Ceram. Abs.*, **9** [9], 759; [12], 1100 (1930). W.M.C.

Applying diffusion calculations to drying porous solids. A. B. NEWMAN. *Chem. Met. Eng.*, **38** [12], 710–13 (1931).—Equations are given for calculating evaporation in the three stages of drying. A chart is shown for calculating drying times for different shapes and dimensions and examples are worked out using brick clay in (1) brick shape, (2) solid sphere, (3) solid cylinder with two ends and convex surface exposed, and (4) the same cylinder with one end resting on an impervious surface, the convex surface and the other end being exposed. G.R.S.

Improved rotary drier. LOUISVILLE DRYING MACHINE CO. *Chem. Met. Eng.*, **38** [12], 727 (1931).—To overcome mechanical difficulties inherent in the usual double-sheet rotary drier, a tubular drier has been perfected in which the customary central tube is replaced by a number of specially shaped, box-like conduits, longitudinally attached to the inside of the drier shell. The construction of the drier is briefly outlined and illustrated with diagrams. Operating data and heat balance are given for an installation of this drier. G.R.S.

Clay preparation provides key to good quality. ANON. *Brick Clay Rec.*, **79** [10], 471–72 (1931).—Several developments in the proper preparation of clay for the molding processes are described. These include the new pug mill featuring a double shaft and a double chamber, a mixer similar to a concrete mixer for mixing screened clay before delivering it to the wet pans, uniform grain sizing, a simplified disk feeder, a new constant weight feeder, and a new line of ring-roll crushers. The special features of each are discussed. Illustrated. E.J.V.

Efficient molding operations. ANON. *Brick Clay Rec.*, **79** [10], 473–74 (1931).—Considerable attention has been paid to dry pressing, and several new developments in

the way of equipment and method of use have been announced. The use of roller bearings is spreading, and better designed bearings of all sorts are being used. Several new types and improved cutters have been produced. Illustrated. E.J.V.

New hydraulic dry press. BENJAMIN LASSMAN. *Brick Clay Rec.*, **79** [10], 467–69 (1931).—The results now commercially obtained by the mechanical dry press and new developments in this field are discussed. The work on hydraulic presses conducted by the O. S. U. Eng. Expt. Sta. is quoted and several methods for the removal of air from the brick being pressed are enumerated. The method considered most practical is the automatic removal of entrapped air by stage pressing. A full explanation of this method is given. The advantages of high fluid forming are enumerated. Hydraulic equipment has been designed for this type of work and will soon be available for use. Illustrated. E.J.V.

Dry-press process for the manufacture of porous hollow brick with closed ends. ANON. *Tonind.-Ztg.*, **55** [98], 1359–60 (1931).—A new type of automatic press is described. Illustrated. W.C.M.

Why not dry pressing. E. PROBST. *Ber. deut. keram. Ges.*, **12** [5], 272–75 (1931).—P. discusses the advantages of dry pressing as a ceramic manufacturing process and urges its application to the production of building brick. He takes up some of the objections raised against the dry-pressing process and shows how they can be disproved or minimized. E.J.V.

Why not dry pressing. R. WEBER. *Ber. deut. keram. Ges.*, **12** [6], 296–97 (1931).—W. replies to Probst (see above abstract) and points out some weak points in his arguments. E.J.V.

Improvements resulting from closed circuit grinding. D. C. COULSON. *Rock Prod.*, **35** [1], 116 (1932).—C. describes four closed-circuit grinding flow sheets and gives data on comparative grinding costs by the different systems as well as data from tests made on cement ground by the different methods. Illustrated. W.W.M.

Silica grinding. R. L. CAWOOD. *Trans. Ceram. Soc.* [Eng.], **30** [9], 295 (1931).—The installation of a new grinding unit replacing the old ball mills is described. C.G.H.

Crushing and grinding mills. ANON. *Chem. Age*, **25**, 186 (1931).—Gyratory and jaw crushers, ball mills, disintegrators, hourly tonnage, and power consumption are discussed, and a brief bibliography of the last two years is appended. H.H.S.

Developments in colloid mills. ANON. *Chem. Age*, **25**, 187–88 (1931).—New types of Hurrell homogenizers are described. A feature is the absence of entrained air in emulsions. H.H.S.

Electric reflecting furnace. C. BENEDICKS AND J. HAERDÉN. *Z. tech. Physik*, **12** [5], 234–43 (1931).—An electric arc between two carbon electrodes, one of which is water cooled, is arranged in such a way that the rays emanating from the arc are reflected by means of an elliptic copper mirror to a vessel containing the sample to be heated. It is possible to place the sample in the vacuum. Different types of arrangements are described which work according to this principle. The main advantages of this type of a furnace are as follows: (1) it is possible to heat the sample under very pure conditions, (2) substances which are not conductors of electricity can be heated up, and (3) high temperatures will be reached in a very short time. The temperature of the substance may easily be raised to more than 2000°C. The efficiency of the furnace is 25% of the energy applied to the arc. W.M.C.

Study of apparatus for cutting brick, etc. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 264, pp. 172–75*B* (1931).—As an example of practical application of vertical pug mills, a description is given of "treading of clay" in a hard porcelain factory. The origin of the phrase "treading of clay" is explained by illustrations and a description

of the ancient Egyptian and Chinese methods. See also *Ceram. Abs.*, **11** [1], 47 (1932) and this issue p. 185. M.Y.H.

Transport of common and sand-lime brick by means of containers. K. REINER. *Tonind.-Ztg.*, **55** [99], 1369–71 (1931).—Different types of containers for the transport of common and sand-lime brick are described. Illustrated. W.M.C.

Handling brick by mechanical means. ANON. *Tonind.-Ztg.*, **55** [95], 1317–18 (1931).—Different means to unload brick and roofing tile from ship to truck, etc., are described. Illustrated. W.M.C.

Conveying brick by automobile. FROHNE. *Tonind.-Ztg.*, **55** [102], 1414–16 (1931).—In Germany, the transportation of brick is done by trucks and tractors. The tractors pull several loaded cars. Costs of transportation by means of trucks and tractors are compared. W.M.C.

Overhead conveyers in the ceramic industries. G. KLEIN. *Ber. deut. keram. Ges.*, **12** [5], 246–56 (1931).—K. discusses the possibilities and installations of overhead conveying systems in the ceramic industries, citing examples of actual installations now in use. Illustrated. E.J.V.

Eliminate waste operations in handling clayware. ANON. *Brick Clay Rec.*, **79** [10], 482–86 (1931).—In the conveying of raw materials the operations are becoming increasingly more automatic. In the conveying of finished products the trend is toward handling the greatest quantity possible in one operation, *e.g.*, a new rubber belt dressing for use on conveyer belts has been announced; tramrail conveying of raw materials offers interesting possibilities of saving in handling costs; tractors and trailers, the brick grab, and a tiering machine have been introduced for handling finished products in great quantities. Illustrated. E.J.V.

Problems in shipping. ANON. *Brick Clay Rec.*, **79** [10], 488–90 (1931).—The multiple trailer system is broadening the manufacturer's local market and is saving handling costs. Paper wrappers for glazed ware and metal containers are helping to reduce railroad costs. Illustrated. E.J.V.

Developments in machinery and equipment. ANON. *Rock Prod.*, **35** [1], 117–34 (1932).—Developments in rock-products machinery and equipment for the past year are given. W.W.M.

Care of crushing rolls. ANON. *Brit. Clayworker*, **40** [476], 314–15 (1931).—A serious defect in crushing rolls is that known as vibration and every precaution should be taken to eliminate it. Vibration may be recognized by noting the shape of the edges of the pieces of plastic clay which have passed through the rolls. When working perfectly the clay cakes will have a uniform thickness throughout, but if the rolls vibrate because one of the gear wheels is worn or out of center, the cake of clay will vary in thickness. The symmetrical nature of the changes in thickness enables it to be distinguished from the irregularity caused by a stone between the rolls. Grooved rolls are a common cause of poor crushing. A common mistake in the adjustment of crushing rolls is to have an improper amount of clearance between them. R.A.H.

Thermal expansion of heat-resisting alloys: Nickel-chromium, iron-chromium, and nickel-chromium-iron alloys. PETER HIDNERT. Bur. Stand., *Jour. Research*, **7** [6], 1031–66 (1931); R.P. 388.—This paper gives data on the linear thermal expansion of various heat-resisting alloys. The alloys contain 0 to 77% nickel, 5 to 27% chromium, and 0 to 82% iron. The coefficients of expansion of the alloys were determined for various temperature ranges between 20°C and 1000°C, and the effects due to temperature, chemical composition, heat treatment, etc., were determined. Critical regions were located on the thermal expansion curves of some of the alloys. For a given temperature range, the coefficients of expansion of nickel-chromium alloys containing from 0 to about 20% chromium are nearly the same. The effects of chromium content, carbon content,

heat treatment, etc., on the coefficients of expansion of iron-chromium alloys for various temperature ranges are indicated in a figure. The results on the thermal expansion of nickel-chromium-iron alloys were correlated with the structure of the alloys. Transformations from one phase to another caused significant changes in thermal expansion. The effects of changes of composition on the coefficients of expansion of both cast and annealed nickel-chromium-iron alloys are indicated. R.A.H.

Apparatus for determining thermal conductivity. J. W. DONALDSON. *Metallurgia*, **1** [4], 151–54 (1930).—A new apparatus for determining thermal conductivity is described. In using an apparatus of this type, fair accuracy is required if the results obtained are to be of value as physical constants. The following points are considered as sources of errors: (1) mean temperatures, (2) transfer of heat between the bar and the guard ring, (3) direct conduction of heat from the heater to the calorimeter by means of insulating materials, (4) differences in temperatures between the two calorimeters, (5) design of the calorimeter and thermometer pockets, (6) accuracy of the thermocouples and thermometers, and (7) expansion of the test bar. M.V.K.

New automatic combustion indicator. HAYS CORP. *Gas Age-Rec.*, **69** [2], 64 (1932).—This instrument is designed to provide continuous indication of (1) CO_2 alone, (2) CO_2 and furnace draft, (3) CO_2, furnace, and uptake drafts, and (4) CO_2, furnace draft, and flue-gas temperature. The Orsat principle of operation is used. The flue-gas temperature indicator, operating on the thermoelectric principle, is similar to the mechanism used in the portable combustion test. Illustrated. E.J.V.

Apparatus for dilatometric measurements of ceramic and refractory materials. ANON. *Feuerfest*, **7** [11], 169 (1931).—The optical factory of Ernst Leitz, Wetzlar, constructed a "comparator" for measuring the changes of ceramic and refractory materials; this apparatus permits observations of 0.0005 mm. Its description is given. M.V.K.

Novel flow meter. SCHUTTE AND KOERTING CO. *Chem. Met. Eng.*, **38** [12], 729 (1931).—Liquid and gas flows are measured readily with a simple form of flow meter. The instrument known as the Rotameter is made in two types, one a thorough-flow and one an orifice model. Diagrams show the principle of the instrument. G.R.S.

Operation recorder. ANON. *Chem. Met. Eng.*, **38** [12], 729 (1931).—Automatic recording of the performance of any machine where the performance can be expressed as a function of machine speed, such as revolutions per minute, foot per minute, and cycles per hour, is made possible with a new recording tachometer. G.R.S.

"High-strength" separator. DINGS MAGNETIC SEPARATOR CO. *Ceram. Ind.*, **18** [1], 56 (1932).—A magnetic separator has been built which will separate slate from gypsum or coal. It will also remove muscovite, biotite, and pure iron oxide from feldspar. It operates on the induction principle and requires little horsepower. This separator is also usable for the removal of iron from clay slips. W.W.M.

Improved apparatus for thermal conductivity. H. STILES. *Chem. Met. Eng.*, **38** [12], 726 (1931).—The specimen to be tested is clamped between an ice vessel and a hot-water tank. Passage of heat through the specimen is then determined by timing the water-level drop in the measuring tube which depends on the rate of melting of the ice in the cylinder. A diagram of the apparatus is given. G.R.S.

Tests with the interposition of elastic materials between the bed of the testing machine and the compressed faces. G. BAIRE. *Rev. mat. constr. trav. pub.*, No. 265, p. 406 (1931).—Tests were made with pasteboard, paper, and rubber and the conclusions reached were as follows: (1) In almost all cases there was a loss of resistance. (2) With four layers of cardboard the resistance was greater than with one. (3) Wet pasteboard gave a much weaker resistance than dry. (4) The loss of resistance was more noticeable in short tests. (5) Paper gave practically the same results as paste-

board at equal thicknesses. (6) Rubber and particularly thick rubber produced great loss of resistance. (7) The results varied according to the thickness of the elastic material interposed. M.Y.H.

Industrial temperature-measuring instruments. ANON. *Instrument World*, **3**, 61–64 (1930).—No single instrument has yet been devised suitable for measuring the complete range of industrial temperatures; choice of types must be made for each process. Thermometers and pyrometers are classified into contact, electrical resistance, thermoelectric, and distance (radiation or optical) types. Various models of recorders, indicators, etc., as made by the Cambridge Instrument Co., are illustrated. H.H.S.

Exhibition of instruments for investigating dust-like materials. ANON. *Tonind.-Ztg.*, **55** [96], 1327–28 (1931).—For many purposes, it is important to know exactly the amount and grain size of dust-like materials. An exhibition of instruments to investigate such materials was arranged in Berlin, Germany. The instruments comprise, mainly, microscopes and elutriation and wind-sifting apparatus. Special small drying ovens and color-measuring devices have been developed for dust testing as well as installations to measure the humidity, permeability, etc. W.M.C.

Testing of glazes, engobes, and clay slips. ANON. *Tonind.-Ztg.*, **55** [97], 1345–46 (1931).—Different apparatus to test the consistency of glazes, engobes, and clay slips are described. The instruments used include Araeometers, a standardized comparison method to determine the specific weight and the amount of dry substance in the body investigated developed by Herzog, and viscosimeters which are based on measuring the time necessary for a given amount of slip to flow through an orifice. The amount of water for a slip can be calculated from the specific weight and the content of dry substance in the material tested. W.M.C.

Measuring consumption of heat. H. NETZ. *Arch. Wärmewirt.*, **12** [12], 345–48 (1931).—Different apparatus are described which measure the heat consumed employing the expansion of a liquid or the change of electric conductivity of a wire. Illustrated. W.M.C.

Study of shoveling. F. H. CLEWS. *Brit. Clayworker*, **40** [475], 298–302 (1931).—The work of the shoveler can be classified into (1) time spent in actual shoveling, sub-divided into (*a*) penetrating mass, (*b*) lifting mass, (*c*) throwing mass, and (*d*) return to first motion; (2) time spent picking down, considered as rest; (3) wheeling and dumping time; (4) time spent resting divided into (*a*) definite rest periods and (*b*) delays due to interferences; and (5) time spent other than in shoveling. The article discusses shoveling into a shute, shoveling into a wheelbarrow, into a wagon, wear of shovels, and type of shovels recommended. See also *Ceram. Abs.*, **11** [1], 66 (1932). R.A.H.

Digging earth for weathering. ANON. *Brit. Clayworker*, **40** [475], 285 (1931).—Small mechanical excavators enable one man to do the work of four diggers. There are several types, each more suitable than the other for certain types of service. A secret of successful weathering is laying the clay in shallow beds into which the frost can readily penetrate, a superficial exposure to frost doing no good. A helpful method in weathering clay is to water each layer of material. R.A.H.

Equipment developments in the pottery industry. A. R. WELLS. *Ceram. Ind.*, **18** [1], 37 (1932).—W. describes some of the newly developed machinery and its use and operation in the pottery industry. A plaster mixer, batch scales, spreaders, and automatic clay-working machines are included. W.W.M.

Testing natural rocks. ANON. *Tonind.-Ztg.*, **35** [97], 1344–45; [98], 1360–61 (1931).—Preliminary standards for testing natural rocks have been developed in Germany covering the sensitivity to percussion and to wear. The apparatus proposed for these tests are shown and the methods described. W.M.C.

Pottery engineering; its failures and possible improvements. W. PODMORE. *Trans. Ceram. Soc.* [Eng.], **30** [9], 301 (1931); for abstract see *Ceram. Abs.*, **10** [7], 509 (1931). C.G.H.

Gas protection in the industries. G. HELM. *Ber. deut. keram. Ges.*, **12** [6], 286–89 (1931).—Some cases of fatalities due to gas poisoning are cited. The use of gas masks or respirators as a safeguard and the principles involved in the devices are explained. E.J.V.

Dust and fume prevention. P. E. LANDOLT. *Can. Mining Jour.*, **51** [24], 574 (1930).—The success of the Cottrell electrical precipitation system for dust, fumes, etc., as installed in a number of Canadian factories is described. See also *Ceram. Abs.*, **10** [12], 852 (1931). W.C.O.W.

Inspection of the A. E. G. plant for electro-firing in Nürnberg. G. HELM. *Ber. deut. keram. Ges.*, **12** [10], 530–33 (1931).—This description of plant equipment and layout is presented to stress the use of mechanical conveyers. Illustrated. E.J.V.

BOOK AND BULLETIN

Monograph of Viscometry. GUY BARR. 318 pp. Reviewed in *Jour. West. Soc. Eng.*, **36** [6], 365 (1931); for abstract see *Ceram. Abs.*, **10** [9], 665 (1931). W.W.M.

List of permissible mine equipment. L. C. ILSLEY. Bur. Mines, *Information Circ.*, No. 6538, 16 pp. This list includes practically all the electric air compressors, coal drills, mining machines, loading machines, conveyers, mine pumps, room hoists, mine telephones, rock dusting machines, switches, electric hand and trip lamps, electric flood lamps, blasting units, storage battery locomotives, tandem locomotives, power trucks, and concrete mixers tested and approved by the Bureau up to July 1, 1931. See also *Ceram. Abs.*, **10** [3], 211 (1931). R.A.H.

PATENTS

Smelting furnace. ARTHUR JONES. U. S. 1,838,145, Dec. 29, 1931. In a device, the combination with a furnace supported by means permitting rotation thereof on a substantially horizontal axis, of a burner for the furnace provided with a nozzle discharging in the direction of the length of the furnace, the nozzle being inclined to the axis of the furnace to direct the flame upwardly at an acute angle to the surface of the contents of the furnace, and a return passage for the products of combustion adjacent the nozzle.

Measuring fineness of finely divided materials. ROBERT T. KNAPP. U. S. 1,838,628, Dec. 29, 1931. An apparatus for measuring the fineness of finely divided solid materials comprising a settling tube adapted to contain a column of liquid, means permitting introduction of a sample of finely divided solid material into the settling tube to cause the particles of the material to settle toward the bottom of the settling tube at a rate dependent on the fineness thereof, and means for recording variations in pressure in the settling tube at a point below the top of the liquid column during a certain period of time following the start of the settling operation.

Chromium plating. JOHN F. K. MCCULLOUGH AND BENJAMIN W. GILCHRIST. U. S. 1,838,777, Dec. 29, 1931. A process for chromium plating which comprises passing an electric current through a bath with a chromium anode and formed by dissolving in water chromic chloride, one or more of the alkaline metal and earth metal chlorides, oxalic acid, and nitric acid.

Cutting slate, roofing tile, etc. GUSTAVE F. NEUMANN, JR. U. S. 1,838,782, Dec. 29, 1931. A machine comprising a frame having a fixedly mounted member, a movable chisel carried by the frame and coöperating with the member, a revolubly mounted shaft slidably guided within the frame and having a striking portion for actuating the chisel, a slidable bearing carrying the shaft, an adjustable spring bearing upon the

cross head, a cam carried by the shaft, and an adjustable projecting member coöperating with the cam, whereby when the shaft is rotated, the chisel will be struck blows whose force may be adjusted, and whereby the stroke of the slidably guided shaft may be adjusted.

Mixing finely divided solid materials. EVALD ANDERSON. U. S. 1,839,456, Jan. 5, 1932. The method of mixing heterogeneous finely divided solid materials in a dry state which comprises introducing the materials into a closed chamber, injecting gas under pressure into the materials successively at a plurality of points of different elevation beginning at the highest of the points, maintaining the injection of the gas from the lowermost points until the materials are well mixed, and removing the materials from the chamber at a point adjacent the bottom thereof.

Kilns, Furnaces, Fuels, and Combustion

Tunnel kilns. R. SYLVANY. *Céramique*, **34** [523], 249–69 (1931).—(1) *Purpose.* The purpose of the tunnel kiln was to save fuel by means of a steady fire and steady temperatures. S. presents an outline of the progress of tunnel kilns during the last twenty years. (2) *Cross-Section.* The comparatively small cross-section of the tunnel kiln provided temperature uniformity and permitted rapid loading, firing, and unloading. The proportionate weight of kiln furniture could be reduced. On the other hand, the kilns had to be made very long. Kilns of larger section were made possible by arrangements for transverse gas flow. A silica-brick kiln is given as an example. (3) *Length.* Length is an important consideration. They were better a little long than a little short. The length is governed by (*a*) space available, (*b*) firing curve, and (*c*) cross-section. In the preheating zone, the difference in temperature between gases and ware increases toward the loading end. This permits a short preheating zone but detracts from thermal efficiency. Ceramic considerations, however, warn against rapid reheating. Methods for avoiding large temperature differences are described. The length of the cooling zone can be reduced without loss in thermal efficiency by taking heat through the walls and using the heated air for drying. The length of the firing zone depends on the nature of the ware. (4) *Dressler Muffle Kilns.* S. outlines the development of the Dressler tunnel kiln and explains how the present kiln functions. The use of silicon carbide ware supports is discussed. (5) *Application to Ceramics.* S. describes evaporation, dehydration, oxidation, vitrification, and cooling as they take place in a tunnel kiln. (6) *Fuels and Furnaces.* The use of the following fuels is discussed: (*a*) direct-fired fine coal, (*b*) coal fired on grates, (*c*) coal fired in semi-producer fire boxes, (*d*) coal, coke, etc., used in independent producers, (*e*) city gas, (*f*) natural gas, and (*g*) fuel oils. (7) *Industrial Results.* S. compares a tunnel kiln with periodic kilns firing the same ware. In fuel and power the tunnel kiln showed a saving of 390,000 F a year; the use of muffles dispensed with saggers and saved 400,000 F a year, and labor savings were about 300,000 F. The total saving was about a million francs a year. The progress of the tunnel kiln in France has been held back for ten years because of ungrounded fears that it was not practical. S. refutes the arguments that have been raised against tunnel kilns. (8) *Electric Tunnel Kilns.* S. discusses the conditions under which the use of electric tunnel kilns becomes profitable and points out that they are meeting with success in England. A power rate of about one quarter franc per kilowatt-hour appears necessary. The development of the Moore-Campbell electric tunnel kiln is described. Its advantages are pointed out and operational data are given in detail for a decorating kiln. Operation at 1000 to 1100°C in enameling (on tile, pottery, etc.) is also described. An account of the discussion following the paper is included. A.E.R.W.

Circulation in tunnel kilns and its control. S. R. HIND. *Colliery Guard.*, **143** [3701], 1913 (1931); *Brit. Clayworker*, **40** [476], 336–40 (1931).—The normal circulation of gases in open-fire tunnel kilns, particularly in the preheating and cooling zones, is reviewed and the conditions for convective heat exchange are examined. The clearance between the sides of the tunnel and the setting is considered to be the main path of flow of gases and this results in low efficiency of heat exchange. Methods of controlling natural circulation to the best advantage are examined and it is concluded that while such methods have resulted in notable improvements, particularly in respect to greater uniformity of heat treatment, they cannot be expected to lead much further. The possibilities of forced circulation already demonstrated for special cases, as in the firing zone, are examined more generally and the suggestion is made that ceiling fans of heat-resisting steel might be used to greatly reduce the length of tunnel needed for a given treatment or to increase output from a given tunnel kiln. The cost of construction, necessary floor space, and fuel consumption would be considerably reduced and the uniformity and quality of the product improved. R.A.H.

Use of tunnel kilns in firing white ware. J. T. ROBSON. *Fuels & Fur.*, **9** [4], 489–92 (1931).—(1) *Time of Firing.* Typical firing curves and diagrams of typical kilns are given. In bisque firing, there are about 310 dozens per car; in glost, about 150 dozens. Eighteen kiln cars equal one 16-ft. periodic kiln. With a direct-fire kiln, both bisque and glost can be fired in the same kiln. (2) *Fuel Consumption.* Fuel consumption is from 22 to 25 cu. ft. of gas per dozen of glost and 25 to 28 cu. ft. per dozen of cone 9 bisque, about one-third that of periodic kilns. Uniformity of temperature is shown by photographs of cone plaques. (3) *Decoration.* The latest kiln for decorating or firing European bisque is a twin-muffle tunnel, about 80 ft. long, each muffle being 18 in. square. Bisque is fired in 7 hr., but 9 hr. are required for decorating. Other muffle kilns use moving cars and fire decorations in 10 hr. at the rate of 4200 dozens per day. Direct-fired rotary kilns with a revolving platform 60 ft. in diameter fire 3500 dozens per day. A.E.R.W.

Multiburner type tunnel kiln used in firing white ware. ANON. *Fuels & Fur.*, **9** [9], 1075–78 (1931).—Description and diagrams are given of a kiln in the new white ware plant of the Hall China Co. A.E.R.W.

Mechanical firing of continuous kilns. J. WELTER. *Rev. mat. constr. trav. pub.*, No. 264, pp. 161–63*B* (1931).—The most important advantages are the improvement of firing, increase in efficiency of kilns, and economy of fuel. M.Y.H.

Small tunnel kiln for firing delicate colors. RED WING (Minn.) UNION STONEWARE CO. *Ceram. Ind.*, **18** [1], 28–29 (1932).—A new design of a small cross-section kiln is described. It permits firing over a wide temperature range (cone 03 to cone 8), and the first installation shows flexibility of control and equal heat distribution. The kiln is 102 ft. long and has setting space with a 28-in. square cross-section. The plant procedure is described briefly. W.W.M.

Experimental studies of continuous kilns during 1930 by the technical service of the French Society of Ceramic Manufacturers. V. BODIN AND P. GAILLARD. *Céramique*, **34** [520], 146–54 (1931); *Brit. Clayworker*, **40** [475], 283–85 (1931).—(1) *Kilns.* Tables give complete data on the operation of 22 continuous kilns making brick, tile, and hollow tile. The fuel consumptions reported are shown in Table I.

TABLE I

Stoking	Draft	Fuel Consumption (kg. of coal of 7000 cal./g./kg. fired product)
Manual	Natural	62.1, 64.5, 115.5, 57.8
Manual	Artificial	63.5
Automatic	Natural	46.5, 49.7, 60.9, 54.0, 50.4, 68.1, 71.3, 66.8, 67.1
Automatic	Artificial	45.8, 57.0, 45.3, 67.6, 55.5, 48.8, 56.4, 55.2

From the data obtained it is shown that the efficiency of kilns can be increased remarkably by scientific study, and the duration of firing can be greatly reduced. (2) *Driers.* Operating data on five driers (2 chamber and 3 tunnel) are compared with the characteristics of the bodies as determined by Bigot's curve and the test drier of Bodin and Gaillard. For each drier a chart is shown in which the drying curves for ware in different parts of the drier are compared with the curve of maximum drying rate determined experimentally. The two chamber driers were drying ware made from clays of almost identical characteristics but one required more than four times the drying time because of poor circulation and lack of rational drying in two steps. The drying times of two of the tunnel driers were greatly reduced, in one case by avoiding an intermittent schedule and reducing the size of the return flue, and in the other by decreasing the density of setting at the middle of the cars. See also *Ceram. Abs.*, **10** [4], 290 (1931). A.E.R.W.

Electric circular kiln. AJAX ELECTRIC CO. *Ceram. Ind.*, **18** [1], 56 (1932).—The Ajax Electric Co., Philadelphia, Pa., has developed a new circular electric decorating kiln. The kiln, its operation, and characteristics are described. W.W.M.

Design and testing of a laboratory kiln. W. HARRY VAUGHAN AND J. P. BREEN. *Jour. Amer. Ceram. Soc.*, **15** [2], 149–53 (1932).

Laboratory test kilns. A. S. WATTS AND J. L. CARRUTHERS. *Jour. Amer. Ceram. Soc.*, **15** [2] 154–57 (1932).

Concentrating heat in brick kilns. ALBERTO PELLACINI. *Corriere Ceram.*, **12** [11], 449–53 (1931).—The surest method for obtaining a minimum radiation of heat in brick kilns is through the use of porous brick, air spaces, and sand in the construction of the kiln. P. gives details of the construction of an efficient kiln. M.V.K.

Operation of driers and kilns from the practical point of view. E. LOMBARD. *Céramique*, **34** [521], 185–91 (1931).—For good firing, it is necessary to dry well, and to dry well, it is necessary to form correctly. Only homogeneous and sound ware should be put in the driers and kilns. Before a factory is built, available clay in the commercial sense must be assured, and radical changes in a manufacturing process should not be made until it is certain that the clay available is suited to them. (1) *Driers.* In putting a tunnel drier into operation, the rate of drying is increased week by week until the safe drying rate is exceeded. The rate is then reduced slightly. The following rules are used: (*a*) Only bone-dry products should be taken from the drier and the regularity of the schedule must not be disturbed for any cause. (*b*) The useful length of the drier should not be reduced by taking out too few cars. (*c*) A uniform schedule must be maintained with constant temperature and humidity not approaching too closely to the maximum drying rate. With chamber driers, the loading schedule is apt to be upset by holidays. A 40-chamber drier will dry 5 chambers a day on a 6-day schedule. The most convenient way to secure a steady supply of steam for drying is to operate a central station and utilize the exhaust steam under vacuum during working hours and without vacuum at other times. (2) *Kilns.* The zigzag kiln invented by Jacob Buhrer is more suitable for rapid firing than the Hoffman kiln. The Hoffman kiln is of simple and economical construction and easy to operate at medium speeds. It is excellent for small ware. The density and uniformity of setting in a kiln governs its behavior. A good coal of two sizes should be used and the draft should be proportional to the amount of coal introduced. Other aspects of kiln firing are discussed. A.E.R.W.

Controlled drying and firing. ANON. *Brick Clay Rec.*, **79** [10], 477–79 (1931).—Current developments in drying and firing operations in the clay products industry seek to produce greater economies in fuel requirements, more uniform and effective application of heat, and more exact control of operating conditions. Natural gas has come in for its share of experimentation and many installations for gas firing have been

made. Stoker firing has been studied and the use of small kilns as a supplement to large kilns or for special firing of glazed ware has been considered. Illustrated. E.J.V.

Construction of chimneys for brick plants. ANON. *Tonind.-Ztg.*, **55** [101], 1402–1403 (1931).—Construction and maintenance of chimneys are discussed, and a table for dimensions is given. W.M.C.

Firing silica brick. ANON. *Brit. Clayworker*, **40** [475], 288–89 (1931).—In a natural-draft kiln, fuel is invariably wasted by (1) too much air and (2) leaks in the brickwork. This excess air must be heated to the maximum temperature of the kiln. Saving of fuel and more uniform temperature are obtained by replacing the ordinary fire boxes with semiproducers and supplying air and gas under slight pressure yet obtaining either an oxidizing, neutral, or reducing atmosphere. R.A.H.

Refractory materials for furnace doors. ANON. *Tonind.-Ztg.*, **55** [98], 1358–59 (1931).—The use of refractory materials for the doors of Hoffmann kilns is emphasized, though the initial costs are higher than with common brick. Several advantages are claimed for the use of refractory brick for this purpose. W.M.C.

Fundamentals and economies in the clay industries. XI. ELLIS LOVEJOY. *Clay-Worker*, **96** [6], 330–32 (1931).—The application of mineral reactions to firing structural ware is taken up; a mineral conception of clays being brought out in preference to a chemical analysis conception. Varied firing behaviors of clays are explained in the light of mineral components, mineral reactions in the solid state, eutectic combinations at relatively low temperatures, and solutions of the refractory solids. A discussion of the mode of occurrence in clay of pyrite, iron carbonate, gypsum, lime, and carbon, and the effect of each on the firing behavior of the clay is given in detail. Illustrated. For Part X see *Ceram. Abs.*, **11** [2], 136 (1932). E.J.V.

"Artificial" coal. OTTO HORN AND HEINZ SUSTMAN. *Brennstoff-Chem.*, **12** [21], 409–12 (1931).—Attempts at artificial carbonization of plant matter to form coal are discussed. J.L.G.

American coals and their technical properties. A. C. FELDNER. *Brennstoff-Chem.*, **12** [21], 405–409 (1931).—Three classifications of American coals are presented. These are "rank," "type," and petrographic classification. "Rank" represents the degree of transformation and "type," the nature of the original coal-forming vegetation. The German equivalents for the American classifications are given. The regional distribution and extent of American coals are shown by table. Coke manufacture is briefly discussed. J.L.G.

Directions for the operation of a modern coking plant. ERICH KÖNIG. *Brennstoff-Chem.*, **12** [21], 412–15 (1931). J.L.G.

Content of $CO_2 + O_2$ in combustion gases. W. ARBATSKY. *Wärme*, **59**, 156–57 (1931); *Sci. et ind.*, **15** [209], 53 (1931).—A. studied gases of combustion of coal, particularly brown coal, and discusses the influence of the composition of coal on the value of the sum $CO_2 + O_2$ in combustion gases. In brown coal containing large quantities of oxygen, a value larger than 20.9% for the sum of $CO_2 + O_2$ may be reached in some cases. M.V.K.

Effect of the mixing rate of air and fuel gas on combustion in flues and furnaces. J. W. CUTHBERTSON. *Chem. & Ind.*, **50** [51], 451–57 (1931).—Slow mixing of gas and air gives a long flame and increases the excess air requirements, but this trouble may be largely overcome by preheating the air. In the case of a mixed air-gas stream, increasing the port velocity reduces the cone height and generally also the total flame length. In the case of gas burning in still air, increasing the port velocity increases the flame length, the relationship being a logarithmic form. The shape of the port will be governed by the type of flame required. A convenient form is preferable where it is intended

to give a definite direction to the flame. As the flow of gas is almost invariably turbulent, the question of degree of turbulence has an important bearing on the combustion. Increasing the velocity increases the turbulence, the angle of the emergent stream, and the rate with which it will mix with the air. Friction plays an important part in most cases of gaseous combustion. Its effect has been only slightly investigated so far. G.R.S.

Minimizing hazards of pulverized-coal dust about cement plants. D. B. COLEMAN. *Pit & Quarry*, **23** [5], 37–39 (1931).—As an aid to safe cleanliness it is recommended that (1) buildings be designed to secure minimum lodgment of dust, (2) interior parts on which dust might lodge be accessible for cleaning, (3) inside surface of walls be smooth, (4) white or light-colored paint be used liberally, (5) screw-conveyers and belts be carried on solid flooring to prevent excessive dust spilling, (6) dust-collectors be used, (7) compressed air be used only in connection with a water spray, (8) dust be wet down carefully prior to sweeping, and (9) a vacuum cleaner be used. See also *Ceram. Abs.*, **10** [11], 799 (1931). E.P.R.

Cheap motor fuel from coal. MURRAY STUART. *Queensland Govt. Mining Jour.*, **32** [10], 408–409 (1931).—Experiments by J. D. Smith on the use of creosote as a motor fuel have been successful. One engine using creosote completed 15,000 miles with no need for decarbonizing owing to the tremendous antidetonating properties of the fuel. E.P.R.

New type of automatic stoker. ANON. *Brit. Clayworker*, **40** [475], 295 (1931).—The special characteristic of this stoker is that the impulse for each discharge of coal into the kiln is made by a pneumatic attachment in place of the usual mechanical fitting. This method does away with the necessity for a wood framework to support the driving attachments, and the fitting of the feeders to the kiln is more flexible. The apparatus is made of a special aluminum alloy resistant to the action of kiln gases. R.A.H.

Natural and mechanical drafts. SANDRO CELLA. *Corriere Ceram.*, **12** [11], 473–77 (1931).—The two factors which determine the superiority of mechanical ventilators and aspirators over natural draft in kilns are discussed, *viz.*, (1) the possibility of greatly increasing the burning velocity and consequently the production, and (2) a better utilization of fuel and decrease in loss through the chimney. M.V.K.

Fluctuating flow of heat in furnace. R. J. SARJANT. *Colliery Guard.*, **143** [3701], 1913 (1931).—The first part of the paper records an experimental investigation of the flow of heat in the walls of industrial furnaces under rates of heating met with in practice. The flow of heat has been determined under various rates of heating for single and composite walls of varying thickness and composition in different heating operations. In the second part, attempts have been made to correlate the experimental data with such mathematical expressions as may be used to suit defined sets of conditions, and thereby to define the limitations of such conditions in industrial practice. The general conclusions are as follows: (1) From the experimental section of the investigation, curves of heat content of furnace walls and curves of rate of heat flow have been derived for various sets of conditions in which the dimensions of the walls, the lagging, the rate of heating, and the ultimate soaking temperature have been varied. (2) The data have been correlated with theoretical expressions derived from the fundamental conduction equation of Fourier on the basis of the conditions specified in the discussion of the equations. (3) In the series of experiments examined, in the case of lagged walls, the shift of the time scale necessary to give agreement was found to be related to the rate of rise of temperature of the hot surface by a simple linear relation. E.J.V.

Heat transfer. ANON. *Chem. Age* [London], **24** [602], 21 (1931). C.G.H.

Heating refractories from "cold" in fuel-fired furnaces. M. H. MAWHINNEY.

Iron Age, **128** [25], 1556–59 (1931).—Practical tests to determine how long it takes to bring a furnace up to operating temperature and how much fuel is used in the process are described. Tests were made on a small gas-fired furnace, fuel being supplied at various rates. Similar tests on commercial furnaces with different types of wall construction gave results in agreement with the preceding tests. M. found that the time and the amount of fuel required to reach the operating temperature are practically independent of wall construction. A decreasing rate of supplying fuel is more efficient than a constant rate, the most efficient average rate being 10,000 to 12,000 B.t.u. per square foot interior area per hour. See following abstract. H.F.V.

Heat absorption by refractories during operation of fuel-fired furnaces. M. H. MAWHINNEY. *Iron Age*, **128** [27], 1678–82 (1931).—Tests were carried on in the same experimental furnace and commercial installations to determine heat requirements to maintain temperatures. Factors found to be important were wall construction, furnace temperature, and time and cycle of operation. Tables and curves are given to describe their effects. H.F.V.

New electric rapid-gas generator. ANON. *Glashütte*, **61** [45], 836 (1931).—A new electrically driven rapid-gas generator exhibited at the Reichenberger Fair aroused great interest in the glass industry. Apparatus of different sizes were exhibited; the largest type is capable of generating over 100 cc. gas per hr. The gas is obtained from benzine and therefore its production is very cheap. It can be used in the glass industry for melting, cutting, glost firing, etc. M.V.K.

Boric acid in the glaze of the sealed vases of Arezzo. R. NASINI. *Nature*, **126** [3188], 877 (1930).—Collaborating with R. Grassini in his private laboratory in Florence, accurate analyses were made of the glazes taken from fragments of the vases from the potteries of "L (ucius?), Titi," and "Thirsus." It has been affirmed that boric acid is a constituent part of the glaze and is not found merely in occasional traces. See also *Ceram. Abs.*, **10** [6], 461 (1931). W.C.O.W.

New developments in firing in the pottery industry. R. H. PASS. *Ceram. Ind.*, **18** [1], 35 (1932).—P. gives the developments in firing in various pottery plants. A new burner of the air injection type is in use in one plant. Some firing equipment and processes are described. W.W.M.

PATENTS

Tunnel kiln. WILLIAM LEE HANLEY, JR. U. S. 1,838,672, Dec. 29, 1931. A tunnel kiln having its preheating zone or zones provided with a plurality of initial inlets for oxidizing a gaseous medium disposed at intervals along one side of the zone adjacent to the lower portion of the goods space thereof, a longitudinal series of mechanical gas-propelling devices located within the zone adjacent to the inlets and constructed to discharge the medium transversely across the lower portion of the goods space, the zone being provided with a series of outlet ports for delivering the medium together with gases and vapors of preheating from the zone, and means for supplying an oxidizing gaseous medium to the inlets.

Heat treatment of ceramic ware, etc., in tunnel kilns or furnaces. HARROP CERAMIC SERVICE CO. Brit. 363,305, Dec. 30, 1931.

Geology

The system MgO–FeO–Fe_2O_3 in air at one atmosphere. H. S. ROBERTS AND H. E. MERWIN. *Amer. Jour. Sci.*, **21** [122], 145–57 (1931).—The system MgO–FeO–Fe_2O_3 has been investigated at temperatures above 1000° on the isobar $^1/_5$ atmosphere O_2. In the binary system MgO–Fe_2O_3, no compound was found other than MgO–Fe_2O_3,

which dissociates slightly on heating and begins to melt at 1750° ± 25°. Solid solution extends from this compound for a short distance toward MgO. In the binary system FeO–Fe_2O_3, the stable phase at temperatures below 1386° ± 5° is a hematite solid solution containing less oxygen than Fe_2O_3; just above 1386° ± 5°, the stable phase is a magnetite solid solution containing considerably more oxygen than Fe_3O_4. The ternary system contains two solid solution fields. The first begins at MgO below 1000° and extends, with increasing temperature, toward $MgO{\cdot}Fe_2O_3$ and FeO; a liquid phase appears at 1770° ± 25° where the solid contains iron oxide equivalent to 73% Fe_2O_3. The second solid solution extends, with increasing temperature, from $MgO{\cdot}Fe_2O_3$ toward the iron oxide boundary which it reaches at 1386° ± 5°; solid solutions of about 1% of MgO in $MgO{\cdot}Fe_2O_3$ are possible from 1750 to 1000° or below. W.C.O.W.

Hydrated calcium silicates. I. The system CaO–SiO_2–H_2O. II. Hillebrandite and foshagite. VALDIMAR ALFRED VIGFUSSON. *Amer. Jour. Sci.*, **21** [121], 67–78 (1931).—Part I reviews the system CaO–SiO_2–H_2O and illustrates the relations of the various hydrated calcium silicates by means of a graph. The occurrence of anhydrous and hydrated compounds in the system is compared on a molar ratio basis. The physical and optical properties of the hydrated calcium silicates as described in the literature are summarized in tables, while a graph shows that the specific gravities of these compounds vary definitely with the composition of the minerals. Part II presents the results of a detailed study of the minerals hillebrandite and foshagite. The results include X-ray powder data and determinations of the optical properties of both minerals. The specific gravity of foshagite was also determined. This study indicates that hillebrandite and foshagite have the same crystal structure and that differences in chemical composition and variations in optical properties may be explained as due to partial alteration of foshagite by hydrolysis and carbonation. W.C.O.W.

Studies of magnetic sands. I–III. K. IWASÉ, M. FUKUSIMA, Y. SAITÔ, S. MITSUKURI, AND M. KOBAYASI. *Sci. Repts. Tôhoku Imp. Univ.*, **20** [4], 489–559 (1931).—The papers contain experiments as to the possibilities of treating titaniferous magnetic sand, the titanium dioxide content varying from 0.5 to 42%. In the first paper the reduction is made by means of carbon monoxide or solid carbon (charcoal, coke, graphite, etc.). The effects of the grain sizes of the sand and the carbon and of the titanium dioxide in the sand were studied as well as the influence of a reducing atmosphere. In the second paper the effect of siliceous matter upon the rate of reduction was investigated at temperatures of 900 to 1150°C. The influence of siliceous matter, precipitated silica, alumina, and sea sand on the reduction is not very great. Tailings of the magnetic sand which contained some hematite or limonite particles together with siliceous matter were ground in an agate mortar and added to the black magnetic sand. The rate of reduction of this mixture was greatly retarded owing to the sintering of the siliceous matter with the intermediate reduced product, ferrous oxide. In the third paper three kinds of magnetic sand were roasted from 700 to 1100°C in air and then subjected to reduction. The effects of content of the ilmenite in the sand, of the grain size of the sand, of the agitation during roasting, and the temperatures of roasting and reduction upon the degrees of oxidation and reduction have been investigated. The advantage of roasting prior to reduction is criticized from the standpoint of the reproducibility and of the economy of heat for the reductions. W.M.C.

Bauxite and ceramics. V. CHARRIN. *Céram. Verrerie*, No. 823, pp. 5–7 (1931).—Among the numberless varieties of bauxite it is only those low in iron that can be used for refractories. In the majority of deposits the red bauxites dominate and some of the deposits do not contain the white. The white bauxites occur at the top of the deposits and the red below. M. de Lapparent accounts for this by the loss of iron by the upper layers. C. discusses the different bauxite deposits of France and sets forth the theory

that the white bauxite in the upper strata has been formed by the leaching of the red bauxite. This has been accomplished by vegetable matter. Where only the red is present the white has been removed. Citing M. de Lapparent, he gives the essential minerals of bauxite as kaolinite, goethite, diaspore, and gibbsite. The analyses of four French bauxites are given. *Ibid.*, No. 825, pp. 119–20 (1931).—C. gives the analyses of 18 French bauxites arranged in order of increasing iron content. It is difficult to draw the line as to the iron content of bauxites which can be used for ceramic purposes. One company uses bauxite having a content of 8 to 12% iron oxide but treats it before using by concentrating and removing the iron. This treatment increases the price. At the present time there is very little white bauxite available in the French deposits. Some work has been done on methods of separation of the impurities. Methods of separation by washing have not been very successful on account of the intimate mixture of the minerals. For this reason it is not believed that flotation will give the best results. C. was able to take bauxite containing ferruginous pistolites and after roasting separate these with an electromagnet. He succeeded in increasing the alumina content from 50.4 to 63.1% and in reducing the iron oxide from 30.5 to 12.9%. The silica increased from 5.8 to 7.2% and the titanium from 2.3 to 2.7%. See also *Ceram. Abs.*, **10** [6], 437 (1931). T.N.McV.

Fluorspar deposits in France. ANON. *Génie civil*, **12**, 88–92 (1931); *Sci. et ind.*, **15** [209], 71 (1931); see following abstract. M.V.K.

Fluorspar in France. V. CHARRIN. *Ind. chimique*, **17** [201], 686–89 (1930).—Fluorspar is a calcium fluorine of the formula CaF giving 48.9% fluorine. Its density is from 3 to 3.2 and its hardness is 4. It fuses without decomposing at 1330°. Fluorine is used in glass, crystal, ceramic, metallurgical, and chemical industries and also in the manufacture of artificial cements. France is especially rich in fluorspar deposits; they are situated in the Pyrenees, Bretagne, Vosges, Var, and Central plateau. The description of these deposits is given. See also *Ceram. Abs.*, **11** [1], 55 (1932). M.V.K.

Developments in the feldspar industry: granular glasspar. C. H. PEDDRICK, JR. *Rock Prod.*, **35** [1], 76–78 (1932).—Developments in the feldspar industry during the past several years are outlined and the more recent ones are discussed. W.W.M.

Scandinavian feldspars. JOHANNES BEHR AND HANS LEHMANN. *Ber. deut. keram. Ges.*, **12** [8], 405–11 (1931).—A description of Norwegian and Swedish feldspar deposits, chemical, physical, and geological characteristics of the feldspars, and production and export statistics are presented. Illustrated. E.J.V.

Deposits of refractory raw materials in the Czechoslovakian republic. J. STEJSKAL. *Z. prakt. Geol.*, **39** [9], 129–38; [10], 148–57 (1931); *Feuerfest*, **7** [11], 172 (1931).—A review of deposits, composition, origin, geological stratification, and practical use of kaolin, refractory and slate clay, graphite, magnesite, and quartzite in Czechoslovakia is given. M.V.K.

Valuation of clay deposits. FISCHER. *Tonind.-Ztg.*, **55** [99], 1371–75 (1931).—A general outline is given on the different points to be considered in connection with the valuation of clay deposits. The importance of a geological survey is emphasized. Not only the quality and amount of the clay present should be considered, but also the influence of ground water and the transportation facilities near the deposit. W.M.C.

Bibliography on weathering of natural stone. D. W. KESSLER. *Proc. A.S.T.M.*, **31** [Part II], 804–13 (1931).—Publications dealing with this subject begin with 1851. They are arranged in four groups and cover articles up to and including part of 1931. A brief abstract of each article is given. R.A.H.

Etruria marl. T. ROBERTSON. *Quart. Jour. Geol. Soc.* [London], **87**, 13–29 (1931); *Sci. Prog.*, **26**, 207 (1931).—The theory is advanced that the Etruria marl of the Upper

Coal Measures in England has been formed from the decomposition of the Midland basaltic rocks. H.H.S.

Nonmetallic mineral resources of Arkansas. GEORGE C. BRANNER. *Pit & Quarry*, **23** [5], 40–46 (1931).—The principal nonmetallic-mineral products of Ark. in the order of their relative values are clay products, sand and gravel, bauxite, stone, lime, cement, oilstones, tripoli, and glass sand. See also *Ceram. Abs.*, **10** [10], 729 (1931). E.P.R.

Soviet potash industry. ANON. *Times Eng. Supp.*, **29**, 145 (1931).—Several German firms including Borsig, Siemens, Wolf-Buckau, and A.E.G., are constructing plants in the Ural district for the Russian Potash Trust. Solikamsk and Beresniki are at present the major sites. H.H.S.

BULLETINS

Practical rules for the use of the magnetometer in geophysical prospecting. M. C. ALEXANIAN. Bur. Mines, *Information Circ.*, No. 6527, 19 pp. (Free.) A large number of organizations interested in the search for mineral deposits have adopted the magnetic method of geophysical prospecting, as it has proved to be the most simple, convenient, and rapid, and at the same time the least expensive in comparison with other methods. The purpose of the present article is to show the different sources of error by which the work of an operator may be affected and to discuss the means by which the carrying out of a magnetic survey may be improved. R.A.H.

Shorter contributions to general geology, 1930. W. C. MENDENHALL. Geological Survey Professional Paper, No. 165, 180 pp. Price $1.25 from Supt. of Documents, Washington, D. C. This paper contains a report on lithologic studies of fine-grained, Upper Cretaceous sedimentary rocks of the Black Hills region and papers on a flora of Green River age in the Wind River Basin of Wyo., the geology of the eastern part of the Santa Monica Mountains, Calif., and the Snowy Mountains, Mont., and the kaolin minerals, previously published as advance chapters. R.A.H.

Tourmaline. I. AITKENS. Bur. Mines, *Information Circ.*, No. 6539, 8 pp. (Free.) This is one of a series of papers on gems and precious stones. Tourmalines are borosilicates of a very complex structure. Outside of its use as gems, tourmaline is also used in the manufacture of tourmaline tongs and in measuring the intensity of radium emanations. The report gives general information on properties, history, occurrence, mining, and production. A short bibliography is attached. R.A.H.

Feldspar gems. (Amazon stone, moonstone, sunstone, etc.). I. AITKENS. Bur. Mines, *Information Circ.*, No. 6533, 10 pp. (Free.) The present paper discusses only the gem varieties of feldspar of which 37 are listed. The report gives information on properties, history, occurrence, mining methods, and production. A short bibliography is attached. R.A.H.

Feldspar in 1930. H. H. HUGHES AND JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources U. S.*, 13 pp. 5¢. R.A.H.

Mineral resources of the U.S. in 1930. (Summary.) O. E. KIESSLING AND M. B. CLARK. 120 pp. Price 20¢. Published by the Bur. of Mines, Supt. of Documents, Govt. Printing Office, Washington, D. C. R.A.H.

Geology of the Bobrik-Donskoi fireclay deposits. P. N. JAKOVLEFF. *Trans. Ceram. Research Inst.* [Leningrad], **31**, 12 pp. (1931). M.V.K.

Chemical, mineralogical, and mechanical composition of the Bobrik-Donskoi clays. WOLD. ISKÜLL. *Trans. Ceram. Research Inst.* [Leningrad], **31**, 30 pp. (1931). M.V.K.

Ceramic properties of the Bobrik-Donskoi clays and their use in the refractory industry. K. KÖHLER. *Trans. Ceram. Research Inst.* [Leningrad], **31**, 39 pp. (1931).—K. discusses (1) the ceramic characteristics of the clays, (2) tests with refractory brick

prepared from these clays and with brick prepared from the same clays but with additions of grog, and (3) the production of insulating blocks from the same clays. M.V.K.

Fire clay of the Bayny deposit in the Ural Mountains. A. FEDOSSEJEV. *Trans. Ceram. Research Inst.* [Leningrad], **26,** 43 pp. (1931).—F. treats (1) the geology of the Bayny fireclay deposits, (2) their origin, (3) the mechanical composition, (4) chemical characteristics, (5) mineralogical composition, and (6) physico-chemical properties. The qualitative mineralogical composition of the clay shows the presence of quartz, kaolinite, tourmaline, zircon, rutile, pyrite, feldspar (orthoclase), mica (muscovite), and "disthene." The chemico-mineralogical researches show that the clays are a kaolinite-mica-quartz rock with a certain lime-magnesia and colored mineral content. The ceramic properties of the clays are satisfactory. Their refractoriness is equal to 30 to 32 Seger cones. See following abstract. M.V.K.

Fire clay in the Chebarkal area in the Ural Mountains. V. GONCHAROV. *Trans. Ceram. Research Inst.* [Leningrad], **27,** 41 pp. (1931).—Description and data on the fireclay deposits of the Chebarkal area in the Ural Mountains are given. The chemical composition of the clays shows a high content in silica and a low content in alumina. The quantities of CaO and MgO are small. Among the alkalis, K_2O is prevalent. Ceramic tests show that these clays are of two groups: the first when fired to Seger cones 13 and 14, produces a completely vitrified body; in the second group, the body remains highly porous when fired to the same temperature. The refractoriness varies between Seger cones 28 and 32. See also *Ceram. Abs.*, **9** [3], 202 (1930). M.V.K.

Feldspar of some deposits in the Marioupol district. T. E. KRASSENSKAJA AND V. T. POPOVA. *Trans. Ceram. Research Inst.* [Leningrad], **28,** 29 pp. (1931).—The authors describe (1) the different deposits of feldspar in the Marioupol district, (2) their chemico-mineralogical composition and properties, and (3) tests for using them in porcelain pastes. The feldspars contain albite, quartz, muscovite, biotite, secondary mica, garnet, and brown ferric hydroxide. The Fe_2O_3 content is small (about 0.1%). Tests showed that this feldspar can be used with success for fine ceramics. M.V.K.

Geophysical Abstracts. XXXI. F. W. LEE. Bur. Mines, *Information Circ.*, No. 6575, 30 pp. (Free.) A monthly review is given of books, patents, and articles on geophysical prospecting. For Part XXX see *Ceram. Abs.*, **11** [2], 144 (1932). R.A.H.

Chemistry and Physics

Enthalpy: Thermodynamical potential. A. BARRIER. Intern. Inst. of Cold, 1930 Report (Supplement to *Intern. Bull. Information Refrig.*, **12** [2], April, 1931).—The 5th International Congress of Refrigeration at Rome coined the word "enthalpy" to denote thermodynamical potential at constant pressure, as expressed in the equation $J = U + p\,V$. H.H.S.

Execution of polarization microscope examinations of ceramic materials. E. HERLINGER AND A. UNGEWISS. *Ber. deut. keram. Ges.*, **12** [10], 487–523 (1931).—This brief dissertation of the use and application of microscopic methods to the study of ceramic materials is presented under the following sub-divisions: (1) preparation of thin sections, (2) a survey of the microscopic problem, (3) carrying out an examination with a polarization microscope, (4) the refractive index, (5) methods of determining the refractive index, (6) the powder method, (7) double refraction, the axes, and optical character, (8) determination of double refraction, (9) determination of axes with a polarization microscope, and (10) the polarization microscope. There are also two appendices, the

first consisting of a theoretical explanation of some of the effects observed in using the microscope and the second of a sort of glossary including the most important ideas and characteristics of the microscope. Illustrated. E.J.V.

Simple apparatus for comparing the rate of solution of solid substances. V. Corman. *Chem. & Ind.*, **50** [52], 1057–58 (1931).—The apparatus resembles a hydrometer consisting of a graduated capillary tube, a float, and a small perforated metal boat. When the boat is empty the float is just submerged and the capillary is entirely above the level of the liquid. A substance to be tested is placed in the boat causing the graduated tube to sink. As the substance dissolves the tube rises. A time-curve can be plotted showing the rate of solution. G.R.S.

Crystal lattice of calcium metaborate, CaB_2O_4. W. H. Zachariasen. *Proc. Nat. Acad. Sci.*, **17** [11], 617–19 (1931).—The results of a structure determination of calcium metaborate are given. The crystal is orthorhombic. The unit cell contains 4 molecules CaB_2O_4. Cell dimensions, axial ratios, space group, atom distribution, and the values of the parameters involved are given and the structure is discussed. J.L.G.

Statistical study of some sampling relations with special reference to quantitative microscopy. J. D. Wildman. *Jour. Assn. Official Agric. Chem.*, **14** [4], 563–70 (1931).—Sample variation is discussed and two statistical formulas which closely approximate such variation are presented. In either macroscopic or microscopic analysis this knowledge of the sample error present adds to the value of the analysis. For materials that consist of a mixture of passable and nonpassable units the formula $\sigma = \sqrt{\frac{PQ}{N}}$ is used, where σ = standard deviation, P = percentage of passable units, $Q = 100-P$, and N = size of sample in units from which P is calculated. When N is less than 30, use $N-1$. In quantitative microscopy the formula $\sigma = \sqrt{\frac{\Sigma f(d')^2}{n} - c^2}$ is employed, where σ = standard deviation, f = frequency in any one class, d' = deviation from arbitrary or assumed mean, n = number of subsamples, c = the correction factor $\frac{\Sigma fd'}{n}$, and Σ = summation. J.L.G.

Using ammonia as a deflocculent for suspensions of argillaceous substances. A. Castiglioni. *Ind. chimica*, **5** [12], 1465–68 (1930); *Chim. & ind.*, **26** [1], 114 (1931).—S. suggests the substitution of sodium carbonate and sodium silicate by ammonia as deflocculent; the results obtained are more satisfactory, probably because the formation of insoluble compounds with the carbonate of lime does not occur. Although they have a high density, the pastes remain more fluid which facilitates their use in industry. Five cubic centimeters of ammonia are used for 1 kg. of paste and the quantity of water is also reduced 5 to 10%. The addition of tannin (0.2 g. per kg.) is recommended. M.V.K.

Phenomenon of slip in plastic materials. A. Nadai. *Proc. A.S.T.M.*, **31** [Part II], 11–46 (1931).—While in former times the engineer was satisfied and it was sufficient for him to base his objects of design and his computations on the theory of elasticity which enabled him to find the working stresses in machine parts under the assumption that these latter are stressed purely elastically, recent improvements in design and manufacturing processes are due to a better knowledge of the permanent or plastic deformations of the ductile metals. Plasticity has been recognized as one of the general properties of solid matter which can be utilized in a number of manufacturing processes. In metals, minerals, and rocks, most interesting evidences of regular structural changes have been found after exposing these materials to severe plastic strains and deformations. In the description of the states of equilibrium in loose granular materials, of the plastic

state under which metals flow in the testing laboratory, and solid rocks which have apparently been severely deformed in great depths on a large scale in nature, an attempt has been made to explain certain frequently observed phenomena connected intimately with the limiting conditions of equilibria and to treat these latter from common points in idealizing certain properties of solid matter. On metal or rock specimens subjected to severe stressing, faint traces of locally concentrated deformations in thin layers have been observed. In these thin layers visible on the surface of a test specimen, frequently a pattern with great regularity is disclosed. The strange laws under which they appear have recently attracted mathematicians. The regular markings might offer useful means to study the distributions of stress under which they were produced. To these thin plastic layers, quite analogous phenomena seem to correspond in geology on a large scale. In a greater number of examples taken from practical applications in engineering design and from the branch science of structural geology, the laws of the formation of the slip lines and of the plastic layers have been studied. Through the courtesy of the Research Laboratories of the Westinghouse Electric and Manufacturing Co., a new optical bench has been designed by N. which serves to demonstrate and to study the formation of the plastic slip layers in test specimens with a high degree of accuracy. R.A.H.

Studies on the degree of dispersion of the clays. I. Technique and accuracy of mechanical analysis using the centrifuge. C. E. MARSHALL. *Chem. & Ind.*, **50** [49], 444–50 (1931).—Factors affecting the accuracy of M.'s centrifugal method for the mechanical analysis of the clays in the range 2μ to 50μ are discussed. The pipette method shows satisfactory agreement under proper conditions, and ultramicroscopic counts have also shown that fractions separated by the centrifuge are correctly graded. The effects of departure from the spherical form are fully discussed in the light of M.'s own observations on the shapes of the clay particles. The effect of hydration is also considered, and a more convenient way of determining the actual density of clay particles is given. **II. Influence of cations on the degree of dispersion.** *Ibid.*, **50** [51], 457–62 (1931).—Using the centrifugal method of mechanical analysis it is shown that clays may be divided into different types by a consideration of their degrees of dispersion when saturated with various cations. The kaolin type shows extreme sensitiveness combined with a very small base-exchange capacity. The montmorillonite type is equally well dispersed whatever the cation. The beidellite type shows a very marked variation in the degree of dispersion with various cations and is the type which most readily undergoes oriented coagulation. In this process the particles $< 200\mu$ are chiefly concerned. G.R.S.

Heat treatment of the γ-monohydrate of ferric oxide. R. D. WILLIAMS AND J. THEWLIS. *Trans. Faraday Soc.*, **27** [12], 767–71 (1931).—$Fe_2O_3 \cdot H_2O$ prepared from ferrous chloride by precipitation with calcium hydroxide and subsequent oxidation at room temperature, has the same crystal structure as the mineral lepidocrocite (the γ-hydrate). On heating, it is converted first into the cubic form of Fe_2O_3 and later into the rhombohedral form. There is no definite transition temperature in either case. The first change takes place over a range from roughly 250 to 300°C, and the second over a range from roughly 500 to 600°C. The crystals of the γ-hydrate are of the order of 10^{-5} cm. across, and those of the α-oxide are of the order of 10^{-4} cm. across. When the crystals of the γ-oxide are first formed they are of the order of 10^{-7} cm. and gradually grow to their final size, *i.e.*, just before transformation, being of the order of 10^{-6} cm. G.R.S.

Colors of inorganic salts. C. P. SNOW AND F. I. G. RAWLINS. *Nature*, **125** [3149], 349 (1930).—Examination of the absorption spectrum of anhydrous and hydrated chromium salts seems to indicate that color in inorganic compounds depends upon the

existence of an electronic state of the metal ion separated from the ground state by about 18,000 wave numbers. W.C.O.W.

Glass and ceramics. BERDEL. *Glashütte*, **61** [45], 818–22 (1931).—B. discusses the close relationship existing between glass and ceramics as "fritted porcelain" whose main constituent is glass powder and "hard porcelain" which may be considered as an incipient vitrification of potassium-alumina silicates. Colored and uncolored glazes are especially interrelated. M.V.K.

Modification of glycerol method for determining free lime. G. E. BESSEY. *Pit & Quarry*, **23** [5], 23–24 (1931); see also *Ceram. Abs.*, **10** [10], 733 (1931). E.P.R.

Clay substance; a contribution to the judgment of rational analysis. H. LEHMANN AND W. NEUMANN. *Ber. deut. keram. Ges.*, **12** [7], 327–63 (1931).—The heating behavior of kaolins and clays was studied. Clay substance consists of two constituents, allophane and kaolinite. The allophane portion releases its moisture at about 200°. Its molecular composition fluctuates over a wide range. The kaolinite begins to decompose at 400 to 430°. The greater part is broken up by 500°. The rest of the kaolinite is decomposed between 600° and 800°. The decomposition can be followed easily by X-ray and optical methods. The decomposition product consists of alumina and silica, resembling kaolinite lamella, and also displays a pseudomorphic form. From 800°, further changes occur, through which the alumina and the silica are insoluble. In the specimens heated to 700°, the customary temperature used in rational analysis according to Kallauner and Matějka (see *Ceram. Abs.*, **10** [1], 68 (1931)), the molecular ratio of the clay substance components corresponds about to that of kaolinite. If the clay substance is calculated from the alumina value with the aid of the kaolinite formula there is a difference of up to 1% in comparison with the value obtained by the addition of the decomposition products. Clay substance can be determined to this degree of accuracy by means of the Kallauner analysis. A distinction between kaolins and whiteware clays cannot be made by this means. It was shown that this form of carrying out a rational analysis is reliable enough for general practice by use of a specific example. Illustrated. E.J.V.

Dry distillation of ceramic raw materials. M. LARCHEVÊQUE. *Céramique*, **34** [524], 273–88 (1931).—L. points out that in a one-gram sample of a washed kaolin the analyst must find approximately one milligram each of potash, soda, fluorine, chlorine, and sulphur. With the prevailing methods he cannot find small quantities of compounds which are volatilized or decomposed when the sample is ignited. Dry distillation has shown the existence of such substances. L. cites instances to show that their presence may result in egg-shelling (grésillage) of glazes. A description is given of a dry distillation apparatus consisting of a porcelain retort glazed on the inside and holding 3 kilograms of material, a receiving flask, etc. The results of many experiments performed over a number of years are given and summarized in a table. The materials tested included halloysites, a Limoges glaze, kaolins, refractory clays, micas, and feldspars. The substances recovered by distillation contained water, sulphur, chlorine, hydrogen chloride, fluorine, ferric chloride, etc. L. advances the theory that silica and alumina are weak acids when cold but at high temperatures can drive off chlorine, fluorine, sulphur, etc. L. gives a number of simplified chemical reactions to explain the products of distillation including reactions between silica and sodium chloride, iron oxide and chlorine, alumina and sodium chloride, and silica and calcium fluoride. The decomposition of pyrite and sulphates is discussed. Instances where pyritic sagger clay led to egg-shelling of glazes are cited. L. discusses the practical importance of chlorine, fluorine, and sulphur in firing ceramic ware. The advantage of firing biscuit until most of these substances have been eliminated is pointed out. A table is given showing the amounts of chlorine, fluorine, etc., in various ceramic raw materials. A.E.R.W.

Unit of entropy: The clausius. A. BARRIER. Intern. Inst. of Cold, 1930 Report (Supplement to *Intern. Bull. Information Refrig.*, **12** [2], April, 1931).—The 5th International Congress of Refrigeration at Rome adopted the following definition: A clausius is the increase of entropy that a body takes when supplied with one calorie-gram of heat at 0°C. A kiloclausius refers similarly to a kilocalorie. H.H.S.

Solving relative-absolute humidity conversions. A. J. MONACK. *Chem. Met. Eng.*, **38** [12], 718–19 (1931).—Two ways of expressing the quantity of moisture contained in air are (1) per cent relative humidity (ratio of actual weight of water vapor in a cubic foot of air to the weight of water in 1 cu. ft. of saturated air) and (2) per cent absolute humidity (ratio of the weight of water in a pound of air to the weight of water in a pound of air saturated at the same temperature). Equations are given for converting per cent relative to per cent absolute humidity and vice versa. A conversion chart is also shown. G.R.S.

Testing the binding power of ceramic raw materials. E. KIEFFER. *Ber. deut. keram. Ges.*, **12** [9], 477–79 (1931).—A study of the binding power of nine clays was made, using the clays alone, mixed with 25% sand, and with 50% sand, and determining the cross-breaking strength on the dry bars. The results are given in tabular and graphical form. It is concluded that plastic raw materials should be tested by making a comparison between the dry breaking-strength values for the clay alone and for a 75% clay, 25% ground-sand mixture. E.J.V.

Data. III. T. W. GARVE. *Clay-Worker*, **96** [6], 336–37 (1931).—This collection of data deals with density, weight, heat units, and specific heats. Weights of units of different materials are listed, as are specific heats of another group of materials. For Part II see *Ceram. Abs.*, **11** [1], 60 (1932). E.J.V.

Weathering test procedures for stone. D. W. KESSLER. *Proc. A.S.T.M.*, **31** [Part II], 799–803 (1931).—A study of the technical writings will show a considerable diversity of test procedures aimed at the determination of frost resistance of stone. K. discusses various freezing and thawing test procedures and the type of results that are obtained as well as salt crystallization tests. Miscellaneous tests involving the solvent action on stone of carbonated waters and corrosive atmospheric gases are also discussed. R.A.H.

BOOKS AND BULLETINS

An Introduction to the Principles of Physical Chemistry. O. MAASS AND E. W. R. STEACIE. John Wiley & Sons, New York. 269 pp. Price $2.75. Reviewed in *Can. Chem. Met.*, **15** [12], 46 (1931).—The structure of matter, the gaseous, liquid, and solid states of aggregation, and energy form the subjects of the first half. The latter part deals with solutions, chemical equilibria, velocity of reaction, electrolytic dissociation, and thermochemistry. E.J.V.

Evaporation, Condensation, and Cooling. (Verdampfen, Kondensieren und Kühlen.) E. HAUSBRAND. 7th ed., completely rewritten by M. Hersch. Julius Springer, Berlin, 1931. 359 pp. Reviewed in *Chem. Met. Eng.*, **38** [12], 721 (1931). G.R.S.

Reports of the Kaiser Wilhelm Institute for Silicate Research in Berlin-Dahlem. Vol. IV. (Veröffentlichungen aus dem Kaiser Wilhelm Institut für Silikatforschung in Berlin-Dahlem.) Edited by Friedrich Vieweg and Sohn, Brunswick, 1931. 452 pp. Rm. 38.50. Reviewed in *Chim. & ind.*, **26** [5], 1260 (1931).—This volume contains the following valuable new contributions to the chemistry of silicates: (1) Reports of Cohn on the dilatation of some materials up to 1400° are presented. (2) Nagelschmidt gives data on the structure and the symmetry of complex cyanides of the type of ferric sulphocyanide. (3) Gottfried, Bragg, and West investigate the structure of β-alumina.

(4) Eitel and Lange publish their investigations on the photoelectric recording of absorption curves of colored glasses, the measurement of the transparency and achromatism of optical glasses, and a method for determining the absorption of micromineralogical preparates by photoelectric cells. (5) Lange also presents an apparatus permitting the automatic regulation of the temperature of electric forces of continuous or alternative current. It can be used at all temperatures and has remarkable precision. See also *Ceram. Abs.*, **10** [6], 462 (1931). M.V.K.

Hydraulic properties of kaolinite clays. N. K. ANTONEVICH. *Trans. Ceram. Research Inst.* [Leningrad], **32,** 111 pp. (1931).—A. describes (1) kaolinite clays tested, (2) methods used, (3) properties of kaolinite clays when dried to 110°, (4) properties of the clays when fired to 600°, (5) fired to 800°, (6) fired to 1000°, and (7) changes in properties, *viz.*, quartz, amorphous silica, mechanical mixture of $2SiO_2 + Al_2O_3$, and kaolin and clays. The results of these investigations are as follows: (1) Kaolinite $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$ loses its water when heated and forms anhydrous alumino-silica-anhydride of kaolinite (metakaolin and leverrierite) in which silica and alumina combine completely ($Al_2O_3 \cdot 2SiO_2$). (2) The main difference between the anhydride formed and the raw material (kaolinite) is that the first is chemically active while the latter is inactive. (3) Anhydride of kaolinite produces hydraulic properties in a lime paste. This property is especially well seen in kaolinite when fired to 700° or 800°. Kaolinite fired to other temperatures is less stable. (4) Chemically active anhydride of kaolinite is decomposed by acids and reacts with alkalis. The solubility of its alumina and the fact that it reacts with the calcium oxide confirm its low chemical resistance but not the presence of free oxides. (5) The hydraulic properties of lime-clay mixtures are caused by the reciprocal action of anhydride of kaolinite and lime, and not by the active amorphous silica. Lime-clay mixtures containing from 20 to 60% CaO produce materials much more durable than hydraulic lime and in this respect are similar to Portland cement although they set more slowly. (6) It can be assumed that fired kaolinite clay or pulverized brick fragments may be used as hydraulic aggregates for Portland cement. M.V.K.

Solubility of natural and artificial aluminium oxide and hydroxide in hydrofluoric acid and soda solutions. B. BORODITZKAJA. *Trans. Ceram. Research Inst.* [Leningrad], **30,** 31 pp. (1931).—Raw and fired (to 600°) samples of diaspore sporogelite, hydrargillite, artificial alumina hydrate, and corundum were treated in the steam of a water bath with a 10% HCl solution and stirred continuously. The insoluble residue was treated with a 5% soda solution. The results showed that (1) alumina hydrates and corundum can be classified in the following way with reference to the action of HCl and according to their decreasing solubility: (*a*) hydrargillite and artificial alumina hydrate, (*b*) sporogelite, (*c*) corundum, and (*d*) diaspore. (2) The somewhat high solubility of diaspore and corundum in HCl and soda solution is due to the hydration occurring because of the finely dispersed state of these materials. (3) The higher solubility of corundum over that of diaspore depends on the higher hydration of the first. (4) The solubility of raw sporogelite and that calcined at 400° and 600° is considerably higher than that of diaspore. (5) Amorphous and crystalline alumina hydrate show the highest degree of solubility in HCl at the dehydration temperature (400°). (6) It was found that the solubility of corundum and hydrargillite is reduced with increased firing temperature. Sporogelite has a minimum solubility when raw and a maximum at 400°. Diaspore calcined at 600° is more soluble than that calcined at 400°. Hydrargillite and alumina hydrate dissolve comparatively easily in a 10% HCl solution. Data on the solubility of diaspore, sporogelite, and hydrargillite permit the qualitative and quantitative determinations of these minerals when present in bauxitic clays or bauxite. (7) The dehydration temperature of diaspore and sporogelite can be assumed

to be about 400°, that of hydrargillite, about 250°, and that of artificial alumina hydrate, about 200°. M.V.K.

Book Review

Colloid Chemistry: Theoretical and Applied. Vol. III. Technological Applications. JEROME ALEXANDER. Chemical Catalog Co., New York. 655 pages. Price $10.50. This is the first of a series of papers on technological applications of colloid chemistry. The forty-two papers are divided into two groups, the first consisting of eleven papers on general principles and six papers dealing with mechanical or more specialized matters, and the second group of twenty-five papers dealing with matters beginning with geology and mineralogy, and running to metals, petroleum, asphalt, and agriculture. Of especial interest to ceramists are the following papers: Crushing and Fine Grinding of Quartz; Colloids in Glass; Some Colloidal Properties of Sodium Silicate Solutions; Porcelains and Allied Ceramic Bodies; Ceramic Refractories as Disperse Systems; Colloidal Nature and Properties of Cements and Mortars. For Vol. I see *Ceram. Abs.*, **9** [11], 988 (1930); Vol. II, *ibid.*, **8** [4], 301 (1929). E. J. VACHUSKA

PATENT

Production of yellow iron oxide pigments. KARL OTT AND HERIBERT SCHÜSSLER. U. S. 1,840,326, Jan. 12, 1932. A process of preparing yellow pigments which comprises precipitating a ferrous salt solution with an alkaline acting agent and treating the precipitate in an aqueous suspension with an oxidizing agent in the presence of a substantial proportion of a soluble salt of a trivalent metal.

General

China clay in leather-works practice. ANON. *Leather Trades Rev.*, **64**, 1034–36 (1931).—The "colloidal clay" obtained by delayed sedimentation is most suitable for sprinkling on leather "basils" before rolling. A formula for a wet-grain finish is $1^1/_2$ oz. colloidal clay, $^1/_2$ oz. casein, $^1/_2$ oz. tecnogum, and 1 gal. water. The casein is dissolved in $^1/_2$ pt. of water, using a little borax; the clay is stirred into the solution and then poured into a solution of the gum in the rest of the water. H.H.S.

Economics of the nonmetallic mineral industries. XI. Transportation characteristics and how they affect prices and values. RAYMOND B. LADOO. *Rock Prod.*, **34** [26], 36–37 (1931).—L. considers possible differences in rates due to minimum carloading rules, speed of travel, time in transit, weighing of shipments, and single-line *vs.* multiple-line hauls. For Part X see *Ceram. Abs.*, **11** [2], 141 (1932). W.W.M.

Comments on "New ceramic product claims lowest coefficient of expansion." W. W. WINSHIP. *Ceram. Ind.*, **18** [1], 38 (1932).—W. corrects data on thermal expansion given in the above quoted article (see *Ceram. Abs.*, **11** [2], 114 (1932)), putting fused quartz in the table and showing that it has a much lower coefficient of expansion than Crolite No. 7 and that Invar has the same coefficient as Crolite No. 7. He gives the source of his data. W.W.M.

A new working process for the ceramic industry. P. WANGEMANN. *Ber. deut. keram. Ges.*, **12** [10], 523–30 (1931).—The production method originated in America and known as "continuous flow production," in which the raw materials start in at one end of a plant and the finished product is delivered at the other end, is described and discussed as applied in a ceramic plant. The many advantages of time, labor, and money saving possible by this method are pointed out. Illustrated. E.J.V.

Safe practices in handling and use of explosives in tunnel driving. CHARLES S.

HURTER. *Du Pont Explosives Service Bull; Pit & Quarry*, **23** [7], 70–72 (1931).—Handling and using explosives with safety in tunnel driving present a number of problems that differ somewhat from those encountered in mining. For magazines built in the open, wooden construction with sand-filled bullet-proof walls is the most appropriate type. A few concerns use sectional steel magazines as they can be taken apart at the end of one job, moved to another, and erected there or can be put in storage. These can be bullet-proofed by a sand-filled interior wall. Twelve inches of dry sand will stop the highest-power rifle bullet used for big game. Steel magazines that are exposed to hot summer sunshine should be painted with aluminum paint to keep down the inside temperature. E.P.R.

Research laboratory. ANON. *Factory & Ind. Management*, **83** [1], 34–35 (1932).—The new research laboratory of the A. O. Smith Corp. is described and illustrated. E.C.C.

Application of scientific technical knowledge to ceramic operations. K. ENDELL. *Ber. deut. keram. Ges.*, **12** [6], 283–85 (1931).—The answers to a questionnaire sent to scientific men asking how scientific and technical methods could be made more easily applicable in actual practice are briefly summarized. The concensus of opinion was to continue the highly fundamental studies and several ways were suggested to make the results obtained thereby more easily applied to practice. E.J.V.

Place of science in the modern world. ROBERT A. MILLIKAN. *Jour. Chem. Education*, **7** [5], 1061–73 (1930).—The Bishop of Ripon, a few years ago, suggested to the British Assn. for the Advancement of Science that it would be well for the world if science could take a ten-year holiday. Raymond Fosdick in a book, The Old Savage in a New Civilization, states that "Humanity stands today in a position of unique peril." This peril is laid at the door of science: (1) the alleged impending release of subatomic energy, (2) the implication that science was responsible for the World War, (3) the menace of the machine, and (4) the alleged sin of exalting the material at the expense of the spiritual. M. defends science against these allegations and is not disturbed by expanding knowledge or increasing power except when this comes coincidentally with a decrease in the sense of moral values. If these two occur together, whether they bear any relationship or not, there is real cause for alarm. W.C.O.W.

Working-time measurements in the decoration department in ceramic plants. H. HARKORT AND HEDWIG BOLLHAGEN. *Ber. deut. keram. Ges.*, **12** [7], 363–75 (1931).—A method was developed for the determination of piece-work wages for hand decoration and pattern work with the aid of working-time measurements. The various factors determined and used in developing these wage-fixing methods are discussed in detail. E.J.V.

Man and rationalization. G. HELM. *Ber. deut. keram. Ges.*, **12** [9], 480–84 (1931).—A summary of opinions of various industrial leaders on rationalization of industries and caring for the unemployed during the present critical period is presented. E.J.V.

Fight. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **11** [1], 1–2 (1932).—In these times of economic stress, coöperative effort is urged as it is pointed out that "only in union there is strength." E.J.V.

Cutting down inventories. PAUL W. HARTUNG. *Brick Clay Rec.*, **79** [10], 465–66 (1931).—It is tremendously costly to carry large inventories and in this article H. shows how they may be cut down without impairing service. Illustrated. E.J.V.

Meeting of the German Assn. for the lime, brick, and stone industries in Czechoslovakia. ANON. *Tonind.-Ztg.*, **55** [100], 1390–92; [103], 1432–34 (1931).—The papers read dealt with the economic situation of the ceramic industry, heat economy in firing of lime, testing of hard-fired brick, sieving technic, methods, and machines for the brick and lime industries. W.M.C.

Technical education in Russia. J. G. CROWTHER. *Nineteenth Century*, **110**, 41–55 (1931).—Russia is spending enormous sums on technical education, and all technical students are paid wages. The estimates for technical education for 1931, 1932, and 1933 are 527, 870, and 1292 millions of gold roubles, respectively. H.H.S.

Ceramic Institute of the Technical High School in Breslau. OTTO KRAUSE. *Keramos*, **10** [24], 613–18 (1931).—The Institute and its work are described. M.V.K.

BOOKS AND BULLETINS

Ten years of ceramics, 1920-30. (10 Jahre Keramik 1920–30.) Edited by the Ceramic technical group of the German Main Union of the Industry, Aussig on the Elb. Reviewed in *Feuerfest*, **7** [11], 171 (1931).—This book is devoted to the work of the German ceramic technical group and their reports and meetings during the last 10 years. A series of interesting papers is included, *viz.*, "The influence of the kind of shaping on the behavior of porcelain pastes during drying and firing," by Rieke and Keeding (see *Ceram. Abs.*, **10** [8], 581 (1931)); "The development of standardization of refractories in Germany," by H. Knuth; "The grain size of ceramic masses," (see *Ceram. Abs.*, **9** [12], 1096 (1930)); and "The influence of sudden temperature variations on ceramic products," by Skola (see *Ceram. Abs.*, **10** [8], 572 (1931)). The clay and kaolin deposits in Czechoslovakia and the brick and Dutch tile industries are also treated. M.V.K.

Annual report of director of the Bureau of Standards for the fiscal year ended June 30, 1931. ANON. Bur. Stand., *Misc. Publication*, No. 131, 50 pp. 15¢. The progress of each of the many problems being studied at the Bureau together with the funds available for various groups of projects are briefly given. R.A.H.

PATENTS

Ceramic composition. THOMAS STANLEY CURTIS AND MICHAEL JOSEPH WALSH. U. S. 1,838,809, Dec. 29, 1931. A ceramic composition comprising ceramic materials to which has been added a plasticizing agent in the form of ammonium alginate, the mixture being in dry powdered form.

Purifying silica sand. OTTO C. TRAUTMANN. U. S. 1,840,338, Jan. 12, 1932. The process of rendering silica sand free of its mineral coloring matter comprising admixing citric acid to the silica sand and exposing the mixture to a fusing temperature.

Coloring clay. ROBERT T. VANDERBILT. U. S. 1,841,309, Jan. 12, 1932. The improvement in the dyeing of clay which comprises drying and disintegrating the clay to convert the clay into the desired fineness for marketing, dyeing the fine dried clay by applying thereto, in a continuous manner, a solution of a dye to dye certain of the clay particles without dyeing others, and continuously mixing the dyed clay particles with the undyed clay particles to give a clay product of uniformly dyed appearance, the amount of water added with the dye solution being so limited that subsequent treatment for the removal thereof is unnecessary, and so that the dyed clay can be directly conveyed to storage, packaging, or shipping containers.

Manufacture of articles from basalt. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 363,291, Dec. 23, 1931.

Book Reviews

1931 A.S.T.M. Proceedings. Part I. Committee Reports. New and Revised Tentative Standards. Revisions of Standards. 1119 pp. Part I of the 1931 A.S.T.M. *Proceedings* contains the annual reports of the Society committees and the papers and standards appended thereto. The President's annual address and the annual report of the Executive Committee are also included.

The reports of the standing, research, and sectional committees which function in the metals fields involve the following subjects: (*A*) *Ferrous Metals:* (1) steel, (2) wrought iron, (3) cast iron, (4) iron chromium, iron-chromium-nickel, and related alloys, (5) magnetic properties, (6) magnetic analysis, (7) effect of temperature on the properties of metals, (8) yield point of structural steel, (9) wrought iron and wrought-steel pipe and tubing, (10) corrosion of iron and steel, (11) zinc coating of iron and steel, and (12) fatigue of metals. In this group there are also a number of extensive papers involving (*a*) fatigue tests of low-carbon steel at elevated temperatures, (*b*) low-temperature endurance testing, (*c*) creep-testing apparatus, (*d*) correlation of cast-iron test bar and casting by volume-surface ratio, and (*e*) a bibliography on embrittlement of structural steel in galvanizing. (*B*) *Nonferrous Metals:* (1) nonferrous metals and alloys, (2) electrical-heating, electrical-resistance, and electric-furnace alloys, (3) copper and copper alloys, (4) die-cast metals and alloys, (5) light metals and alloys, and (6) corrosion of nonferrous metals and alloys.

Appended papers discuss the effect of composition on aluminum-base die-casting alloys and lead-base and tin-base alloys for die castings.

Committee reports are given on the following nonmetallic materials: (1) cement, (2) lime, (3) brick, (4) refractories, (5) concrete and concrete aggregates, (6) fire tests of materials, (7) gypsum, and (8) hollow masonry building units.

Papers appended discuss (*a*) concrete curing, (*b*) pavement-core drilling practice, (*c*) analysis of fresh concrete, (*d*) determination of cement content of set concrete, and (*e*) elastic properties of concrete.

Committee reports are also given on the following subjects: (1) preservative coatings for structural materials, (2) petroleum products and lubricants, (3) road and paving materials, (4) coal and coke, (5) timber, (6) classification of coals, (7) bituminous waterproofing and roofing materials, (8) electrical insulating materials, (9) rubber products, (10) textile materials, (11) thermometers, (12) slate, and (13) natural building stones. In this group there are several extensive subcommittee reports and many proposed specifications. Appended subjects include stability tests on coke and psychrometric tables for relative humidity. Other committee reports involve methods of testing, metallography and nomenclature, and definitions. The Committees on Papers and Publications on Correlation of Research and on Standards also have reports in Part I.

In order to give as complete a picture as possible of committee activities, the tentative standards which have been prepared by each committee and subsequently adopted as tentative by the Society are included in Part I of the *Proceedings*. Thus there are 74 tentative standards given, all of which have been adopted and published in 1931 for the first time. Several tentative revisions in standards are also included. In this part of the 1931 *Proceedings* there are reports of 42 standing and research committees and reports of one joint and two sectional committees.

1931 A.S.T.M. Proceedings. Part II. Technical Papers. 1027 pp. Part II of the 1931 *Proceedings* contains the technical papers which were given at the annual meeting of the Society in June, 1931.

The subject matter of many of the papers each year can be grouped under the heading of metals. The 1931 *Proceedings* contain many valuable papers on various aspects of fatigue, endurance testing, magnetic analysis, damping capacity, and corrosion of metals.

A symposium on malleable iron castings comprising 118 pp. of authoritative critical data on the properties of these types of castings is included. This symposium includes, as well, comprehensive technical papers on methods of determining the machineability of malleable iron castings and on the corrosion of malleable iron. Several of the papers involve tests of concrete and concrete masonry and structures made therefrom. The

freezing and thawing of concrete aggregates, central mixed concrete, temperatures in mass concrete, and resistance of fire-clay brick to thermal spalling are some of the included subjects.

A symposium on weathering characteristics of masonry materials takes up 126 pp. These papers bring out available information on the weathering of masonry materials. A bibliography and abstracts on masonry weathering are included.

The abrasion testing of rubber is a subject of interest to all producers and users of rubber and rubber products. A symposium on this subject is given. Comprising 60 pp., it covers such subjects as tear resistance of rubber compounds, abrasion tests of these compounds, and a comparison of the tests made on several types of abrasion machines.

The economic significance of specifications for materials is a subject which should be of great importance to all executives of American industry. This subject was extensively discussed in a symposium held at the 1931 annual meeting by five prominent executives. The papers and discussion thereof comprise 44 pp.

Papers on modern paving emulsions, the hiding power of white pigments, the photoelectric cryptometer, and others are included. There is a detailed subject index and an author index.

Each part of the *Proceedings* is available at the following prices: $5.50, paper binding, $6.00, cloth binding, and $7.00, half leather.

Federal Specifications. A revised index of Federal Specifications known as Federal Standard Stock Catalogue, Section IV, Federal Specifications, Part 1, Index, has just been issued. This index gives the list of Federal Specifications arranged alphabetically by titles, and a list arranged alphabetically-numerically by groups for procurement. Copies of this index may be purchased from the Supt. of Documents, Govt. Printing Office, Washington, D. C., for 10¢.

R.A.HEINDL

Pocket Manual for Ceramists, 1932. (Taschenbuch für Keramiker.) Two volumes. Keramische Rundschau, Berlin. 3.30 Rm. In German only. The first volume is a note calendar containing 19 pp. The second volume has 368 pp. and 50 illustrations and is devoted to the latest questions on (1) firing and fusing kilns of fine ceramics, glass, and enamel industries, (2) oil and gas furnaces and electric kilns, (3) advantages and disadvantages of different systems, and (4) data on the composition, properties, and heat values of different fuels. A review of the literature and a guide for the ceramic, glass, and enamel industries with sources of supply are given also.

M.V.KONDOIDY

Tonindustrie-Kalender, 1932. Two volumes. Tonind-Ztg., Berlin, 1931. 3.30 Rm. Published in German only. The first volume contains day notices and general information, *e.g.*, a table of Seger cone fusing points, patents, mail regulations, etc. The second volume has 336 pp. and 79 illustrations, and deals with the present standing of the manufacture of hollow- and light-building materials. Data for fuels, steam, and power consumption of different operating contrivances, heat values of fuels, brick sizes, output and force requirements of pumps, sieve cloth, weight of building materials, technical literature, etc., are given together with a small technical dictionary.

M.V.KONDOIDY

How Exhibitors Are Meeting the Trade Show Problem. POLICYHOLDERS SERVICE BUREAU, Metropolitan Life Insurance Company, New York. No. 382. Although trade shows appear to be accepted as helpful to business, the opinion of exhibitors in many industries is that methods of conducting these shows must be brought into line with today's changed conditions if buyers of space are to be assured of adequate returns, according to a survey just completed by the Policyholders Service Bureau of the Metropolitan Life Insurance Company. The results of this survey have been published in a report entitled

"How Exhibitors Are Meeting the Trade Show Problem." The report describes the control methods that have been adopted in the different industries. Among the more successful practices reported has been the establishment of exhibitors' committees and boards. The survey indicated that another common method of dealing with the problem is by changing the interval between shows, *i.e.*, "replacing two semi-annual shows with one annual show or the annual show with a show every two years." The opinion was expressed, however, that there is no ideal schedule—"each industry, apparently, must work out the frequency question for itself." Other methods described in the report include reducing the number of regional shows in favor of national shows, making a combined exhibit of two or more previously independent shows, establishing a "limited eligibility" rule, and increasing the control of shows by the exhibitors themselves. The information on which the study is based was obtained from 84 trade associations sponsoring national or regional trade shows. Included in this group were the associations responsible for most of the important national trade and industrial expositions. Executives interested in the subject may obtain copies of "How."

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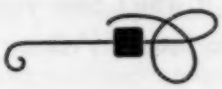

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A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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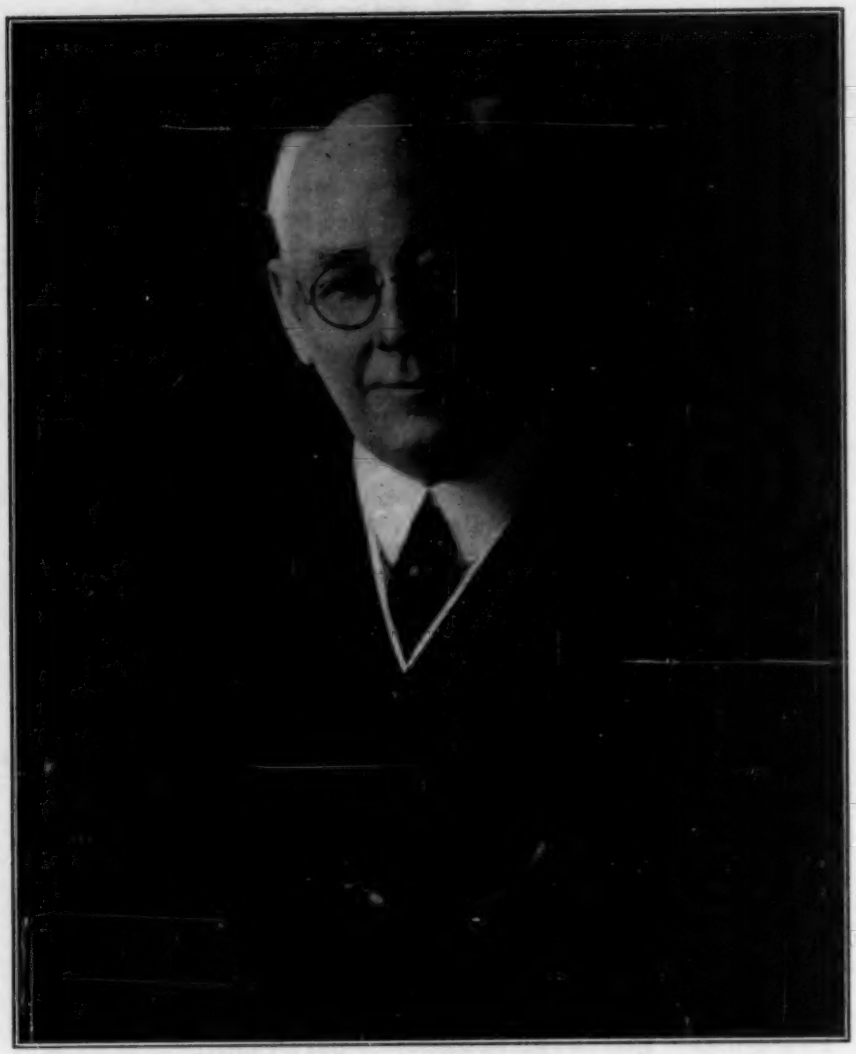
Vol. 11 **March, 1932** **No. 3**

EDITORIAL

GENERAL EDWARD ORTON, JR.

Our founder and leader is gone. But in the death of General Edward Orton, Jr., on February 10, 1932, in Columbus, Ohio, there remains a living and vital monument in the twenty-six hundred members of the AMERICAN CERAMIC SOCIETY. To these members, his effort and success in establishing this SOCIETY in 1899 is by far the greatest accomplishment of a great man whose activities were outstanding in educational, national, and civic advancement. These members are proud that General Orton, with great vision and ability, could establish this organization and nurture and guide its growth through thirty-three years of increasing importance and service. They are proud that this same leader could so ably identify himself in an outstanding way in many other fields, so that his work with the AMERICAN CERAMIC SOCIETY was after all only a parallel successful activity of his life.



EDWARD ORTON, JR.

October 8, 1863—February 10, 1932

We mourn the loss of our leader. We rejoice that in his passing our SOCIETY, as his memorial, has not yet reached its greatest usefulness and development.

For in the growth of the AMERICAN CERAMIC SOCIETY in the years to come, each new advancement and accomplishment will be added honor to the memory of its great founder.

Just so long as the AMERICAN CERAMIC SOCIETY shall exist and foster the high principles and aims which dominated the life and career of General Edward Orton, Jr., just so long will stand a great ever-living memorial to a great man.

Life Sketch

General Orton was born in Chester, N. Y., Oct. 8, 1863, and was brought to Ohio by his parents when two years old and thereafter Ohio was his home state. He was educated in the Columbus schools and Ohio State University, of which his father was first president and from which he was graduated in 1884.

He was twice married, his first wife, Mary Anderson Orton, dying in 1927. In 1928 he was married to Mina Althea Orton of Pulaski, N. Y., who survives him. Other survivors are two sisters, Mrs. Oliver P. Watts of Madison, Wis., and Mrs. Francis C. Caldwell of Columbus, Ohio, and one brother, Dr. Samuel T. Orton, of New York City.

For nearly sixty years the life and career of General Orton paralleled those of the Ohio State University.

As a boy of ten he joined the campus community. He was a member of its seventh graduating class, was for twenty-six years a member of its faculty, and was twice dean of its College of Engineering. Throughout his life he had a deep interest in the welfare of the University.

Directed Ceramics School

Probably the thing in which General Orton took deepest pride from the standpoint of the University was the fact that he succeeded in establishing there in 1894, almost single-handed, the first school of ceramics in the United States, of which he was the first director.

But perhaps the thing that gave him the most satisfaction there was his founding and support of the Edward Orton Memorial Library of Geology in memory of his father. This collection of works on geology is said to be the finest of its kind in the United States. It was dedicated in 1920, its realization having been delayed by the World War.

Active as Student

General Orton showed promise as a student. As a junior he prepared a report on the clays of Ohio which was published in the annual reports

of the State Geological Survey. He was active in the Class Day contests that were a feature of the student life of the 80's.

His interest aroused by hearing another student play a cornet in the old North Dorm, he bought one for himself and learned to play it. Out of this interest grew the first University band, which made its initial appearance at the reception following the 1879 commencement. Records show that General Orton was the second leader of this early band.

Ceramics Law Passed

Following his graduation in 1884, he worked for a number of years in Ohio's mineral industries. Wrestling with technical problems in ceramics, he found almost no professional literature on the subject and few trained men. By 1893 he persuaded the Ohio Brick and Drain Tile Association and the National Brick Manufacturers' Association to push a law to establish a Department of Ceramics in the University.

Skeptics in the legislature dubbed the measure the "Mud Pie" Bill, but it was finally passed. It directed the University trustees to establish the Department. This was done July 1, 1894, and gave Ohio State the distinction of being the first American university to add such a department, as well as the first of its kind in the world.

Laboratory in Basement

The department was located in the basement of Orton Hall, with a small structure outside for the kilns, where it remained for ten years. It was then removed to its present location in Lord Hall. Dr. W. L. Evans, now Chairman of the Chemistry Department, was the first assistant in ceramics. In 1898, Dr. R. M. Hughes, now president of Iowa State College and formerly president of Miami University, was appointed instructor of the Department but resigned to accept a professorship at Miami shortly after his term began. Albert V. Bleininger was then named as instructor in the school and remained until 1906.

Various gifts of machinery and supplies were made to the Department as further evidence of the faith the ceramic industry had in General Orton and his project. By 1908 there were eighteen students in the department, six in the longer course leading to the degree of "Engineer of Mines in Ceramics," and twelve in the short course. The first graduate of the department was Walter M. Fickes, of Steubenville, who received his degree in 1900.

Served as Secretary and President

Partly out of the interest arising from the establishment of the department grew the organization of the AMERICAN CERAMIC SOCIETY in 1898.

General Orton was secretary from its inception until 1918 and president as recently as 1930–31.

In 1902, General Orton was made Dean of the College of Engineering, a post which he held for four years. In 1910 he was again made Dean of the College. From 1899 to 1906 he was State Geologist.

He served the University in many other ways. Among them were:

Member of Faculty Committee, 1911, which studied desirability of establishing the Engineering Experiment Station on the Campus.
Member of Faculty Committee, which recommended establishing first summer school beginning in 1905.
Elected, 1916, one of University's first two Research Professors.
Charter member of Ohio State Chapter of Sigma Xi, scientific society.
Member, 1911, of University's Architectural Advisory Board.

He retired from University work in 1917.

As early as 1916, General Orton talked of establishing the special geology library in memory of his father. When the University trustees set aside for this purpose the rooms in Orton Hall used until 1913 by the general University Library, he had them suitably equipped and furnished at his own expense. Besides contributing to its collection from his own library, he gave $500 each year thereafter for the further purchase of books in the field of geology.

General Orton left the University when the United States entered the War. Despite his age—he was then past 50—he went to the Plattsburg training camp. He was subsequently commissioned as Major and emerged from the war as a Colonel with the Distinguished Service Medal for conspicuous service. He was later made a Brigadier General in the Reserve Corps.

Sponsored Defense Act

General Orton with President Emeritus, W. O. Thompson, Ralph D. Mershon, a well-known engineer, and Col. G. L. Converse, for many years commandant of the University cadets, and a few others, sponsored the National Defense Act, which was passed without change as General Orton had written it.

Honored in Ceramics

Ten years ago, Rutgers University honored him with the Honorary Degree of Doctor of Science. Three years ago he was chosen as one of Ohio State University's 50 leading graduates. Alfred University conferred upon him the degree of Doctor of Laws in 1931. In 1931, Ohio State University gave him the professional degree of Ceramic Engineer.

At the time of his death, he was Chairman of Fellows of the AMERICAN CERAMIC SOCIETY, an honorary group which he had instituted only a little more than one year ago. The first class of Fellows was inducted into Fellowship in February, 1931.

He was a Fellow of the American Association for the Advancement of Science, a member of the Society for the Promotion of Engineering Education, a member of the American Society for Testing Materials, the National Brick Manufacturers' Research Foundation, the Society of Automotive Engineers, and an Honorary Member of the Ceramic Society of England. He was President of the Columbus Chamber of Commerce from 1921 to 1923.

He also wrote several books, among them, Clays of Ohio and the Industries Established upon Them (1884) and The Clay Working Industries of Ohio (1893), and numerous technical articles and reports.

Historical Society Activities

He was a life member of the Ohio State Historical Society, an active worker in it, and served as Vice-President of the Society and as Chairman of the Memorial Building Committee. He conceived the memorial wing of the Museum. He also served as Chairman of the Building Extension Committee and directed the planning and erection of the south wing to the Museum and Library building.

He actively aided in securing a creditable allotment of World War trophies for the Museum and under his leadership the library of the old

Northwest Genealogical and Historical Society has been transferred to the custody of the Ohio Society by George Spahr and Theodore Glenn.

The Orton Memorial Laboratory at 1445 Summit Street houses the Standard Pyrometric Cone Co.

Ideas on Education

General Orton's life was of striking significance. He was a thoroughly educated man and had a sympathetic appreciation of the meaning of education for all the people in this democracy. He thoroughly realized the grades and varieties of ability and understood that these factors must determine the appropriate type and degree of education in individual cases.

He believed that education of the individual results from the unwearying continuation of the process of learning through life and that this process can go forward effectively only when ordered on principles of sympathy, liberality, recognition of individual capacities, and good-natured coöperation. He himself was a living embodiment of the principles which he believed.

Practical Engineer

He was a highly practical engineer and his thinking and his action in that field rested upon well-assumed scientific principles and the engineering problems to which he turned his attention were always adequately solved on this basis. He was an apt student of the application of fundamental scientific principles, and through his studies and experimentation made possible great expansion in the ceramic industry. As an administrator he manifested the vigor and vision which led to eminent success.

He had a high conception of our social order and the forces therein which make for progress or for disintegration; he was keenly devoted to the betterment of conditions of living, of labor, of social enjoyment, and of self-realization.

Engaging Personality

Honesty of thinking, of opinion, and of conduct shown from his countenance, and all persons who met him were at once impressed with his engaging personality and dealt with him on the basis of entire confidence.

He filled an important place in the educational, the industrial, and the social life of the community and had the highest conception of his privileges and his obligations as a citizen. He never spared himself in advancing any of the causes in which he was interested, devoting his time and money unstintingly to the betterment of the community.

Enjoyed Common Life

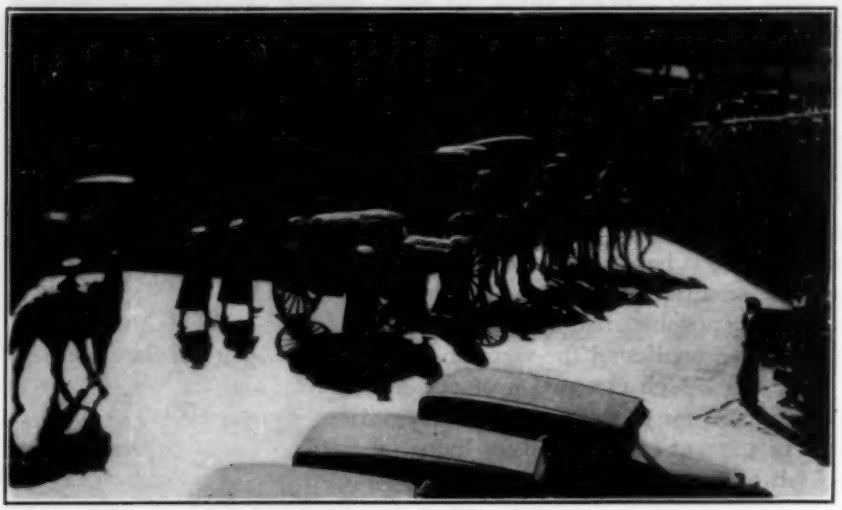
He was a gentleman of refinement and culture, a student, and also a successful industrialist; he mingled with the most select society and also went understandingly and sympathetically among the toilers and the

plain people who enjoy the more common pleasures of life; he never ceased self-education in the sciences and the arts, and was also devoted to practical affairs; he was the highest type of reserved, self-dependent, and resourceful person and at the same time a philanthropist, an apostle of the equal opportunity, and always a moving spirit in civic affairs.

General Orton was treasurer of the Columbus Gallery of Fine Arts and secretary of the Godman Guild Association.

Military Funeral

The funeral services were held in the First Congregational Church with two of his close friends, Dr. M. H. Lichliter, pastor of the church, and



Dr. W. O. Thompson, President Emeritus of Ohio State University, officiating.

Heads were bared along the line of march as the caisson bearing the casket moved slowly from the church to the cemetery amid the slow and muffled beat of the draped drums of the military escort and the measured tread of troops in the procession.

Preceding the caisson were a police escort, the Fort Hayes band, Company A, First Battalion, 28th U. S. Infantry, and the colors. Reserve officers, members of the Franklin American Legion Post, and carriages of the cortège followed.

Final tribute was paid to General Orton with the firing of the last volley and the sounding of taps over his grave in Green Lawn Cemetery.

Dr. W. O. Thompson's Tribute

Dr. Thompson paid honor to the accomplishments of General Orton in his lines of endeavor as an engineer, educator, soldier, and civic leader. His address in part follows:

It was my good fortune to know the first Edward Orton who for a generation lived among us and imbedded himself in the esteem and affection of practically every public school teacher in the commonwealth. He was an economic geologist of more than local fame whose reports to this day are cited as authority on geological questions. He was, however, more than a geologist. He was a great teacher who has left his impression upon hundreds of students.

He was the first president of the University, but never found himself altogether happy in administrative work as contrasted with his keener pleasure of teaching. Notwithstanding this personal preference, the wisdom of his counsel in the early days has left permanent and beneficent influence on the fundamental principles for which the

University has always stood. The University in itself is a complete defense of the wisdom and standing of its first president.

Edward Orton, Jr., grew up in a family marked by the quality so much desired among us.

He was a rugged, vigorous boy who took his educational and other experiences in a wholesome way. His humorous description of many of his experiences was the finest testimony to his own attitude toward his boyhood opportunities.

The intimacy of our personal relations permitted a vigorous debate between us when Professor Orton gave consideration to the deanship of the College of Engineering. When I tried to persuade him that he was stepping from an eminence in an important science and industry to the routine of administration, which could be done only at a great sacrifice, and tried to urge the importance of his place in the field that up to that moment was altogether his own, his modest reply was, after naming three or four men whom he had educated beyond his own achievements in ceramics, "I feel perfectly safe in turning over to these men the future of ceramics in the field of education."

His connection, however, was not entirely broken. Within the past two years he has been given international recognition for his place in this area of applied science.

Edward Orton, Jr., laid hold of a good many opportunities any one of which would ordinarily be considered as worthy of a man's life. He developed these enterprises until certain definite results had been reached. He then transferred his interest and activity to some new enterprise.

The life of Edward Orton, Jr., appears to have had three distinct features.

First, the period of his fundamental education shot through with the ambitions of young manhood. These were entirely appropriate and gave expression in a very vigorous way to the development of a rugged, vigorous man.

His second period was filled with the realization of these ambitions through the completeness of his work in the several enterprises to which he gave his hand and heart

It has always seemed to me that Edward Orton, Jr., left from year to year more well-finished tasks than any man I knew. Now that his career has been closed I review his experiences with a supreme satisfaction that so many of his tasks stand as completed pieces of work ready for an indefinite service. He looked well to the future in the completeness of these tasks.

The third period of his life was the period of interest in philanthropy, civic improvement, the Community Fund, and, in general, the interests of good citizenship. The career by which he passed from the vigorous, physical student, through the war period on to his brigadier generalship is the steady progress and the rapid change from one

field of activity to another. The completeness of these services in themselves makes us think of so many units of his life.

As a concluding observation I desire to bear my testimony to more than thirty years of constant and somewhat intimate comradeship.

Through these years Edward Orton, Jr., has steadily grown to maturity, revealing a refinement of mind and heart, a culture in his life, and a social point of view that seems to me to be the maximum development of an American citizen. He matured and at the same time became increasingly human, refined, cultured, and in every way a citizen of distinction worthy of our confidence, our esteem, and our affection.

Brigadier General Orton's horse (showing rider's reversed boots).

It always interested me to note the steady development of a sense of humor and the increasing hold upon him due to human affection. General Orton genuinely loved his fellow citizens and colleagues with whom he came into closest contact. His career is an open book. It was largely the result of his own native ability plus the kindly coöperation of men of similar tastes. His devotion was unquestionably to science pure and applied and later to the social application of science as a remedial agent for the solution of economic and social situations.

We bid him farewell with full recognition of the importance of his service to science, to education, to his community, and to his country. He was a clear-minded, tolerant citizen who steadily grew in his capacity for service and in the esteem and affection of his colleagues. His life is an unanswerable argument for the hope of immortality which cheers us on our way.

"He matured and at the same time became increasingly human, refined, cultured, and in every way a citizen of distinction, worthy of our confidence, our esteem, and our affection," Dr. Thompson eulogized.

Address of Dr. Lichliter

There is a poem by William Wordsworth which has been called a "manual of greatness." It is too long to be recited. It lends itself to quiet reading because of the almost Roman majesty of its simple but weighty speech. May I urge you to turn to Wordsworth's poems in the quiet of Sunday afternoon and read carefully "The Character of the Happy Warrior."

Who, if he rise to station of command,
Rises by open means; and there will stand
On honorable terms, or else retire
And in himself possess his own desire;
Who comprehends his trust, and to the same
Keeps faithful with a singleness of aim,
And therefore does not stoop, nor lie in wait
For wealth, or honors, or for worldly state.

It is a vignette portrait of General Orton. Let me sum up the message of the poem in a single sentence, as I mention the specific characteristics of a man who has a right to be called the Happy Warrior: high aims, the cultivation of the intellect, moral rectitude, the power to educe good from evil, tenderness, placability, purity, fortitude, obedience to the law of reason, the choice of right means as well as right ends, fidelity, joy in domestic pleasures, and heroism in the great crises of life.

I ask those who have known this man through the years, is there a single quality which may not be applied to him?

Knowing this family as I do, I know that they would have preferred a quiet, almost impersonal service for this hour. But they know, as we all know, that General Orton belonged in a real sense to the wider community of city, state, and nation. He had projected his life on a large canvas. It would be a most impressive list if we were to attempt to mention the wide range of his activities and to interpret his flair for public service. The newspapers have told this story of a useful life and it will be told again and again in more formal statements from the University, the various civic organizations, and the learned societies to which he belonged.

Today our thought is focussed upon the character and spirit of the man. Dr. Thompson has spoken of the units of constructive service which General Orton has rendered and of the impressions which have grown out of years of personal contact. It will be our temptation as we think of him to dwell upon our unique sense of loss. We find ourselves wondering how we can ever get along without him in this city. General Orton would have been the first to insist that no man is indispensable and, of course, that is true, but it is equally true that no man among us has been so unselfishly useful.

May I dwell upon the unselfish spirit of the man. So many men in public life seek something for themselves, office, financial remuneration, the sense of power. One reason why General Orton meant so much to every cause he served was the obvious fact that he had no axe to grind, that he asked no reward, that he thought of himself only as a useful means to a common end.

He had strong personal convictions. His convictions were based upon the most careful, shall I say almost meticulous, investigation of the facts involved. One of his colleagues, a past-president of the Chamber of Commerce, told me that while on occasion men might disagree with General Orton's interpretation of the fact or disagree with the procedure suggested, no one could doubt the accuracy of his findings.

It is just at this point that his essential greatness emerges. If after patient study and a sturdy battle for his point of view he found himself in a minority, there was never the slightest personal resentment. He would say, philosophically, we must go on, let the chips fall where they may. The cause was always more to him than the success or failure of his own plan. Community coöperation in the interest of a better human life for all was the supreme objective in General Orton's public service.

May I ask you to recall his intellectual integrity and his absolute honesty. He would not permit himself to affirm what he did not sincerely believe. He was so independent in his thinking that he could not allow himself to be put in any false light. He honored me several times in these last eight years by talking unreservedly concerning his attitudes toward religion and the church. He used to say that if he could join any

church it would be this church because it officially grants to every man a right to his own individual interpretation of religion and asks no acceptance of any formal creed or code.

Without betraying any confidence I may say that in the matter of specific doctrines we marched together in almost everything except where a certain mystic attitude entered the discussion. His scientific training made it impossible for him to go beyond the analysis of facts, although he himself lived a rich, full, satisfying subjective life. He hated sham, pretence, dogmatism, intolerance. He loved the challenge to service, the imperious demands for purity of life, the essential supremacy of absolute business, and intellectual and spiritual integrity.

He came regularly to this church with Mrs. Orton when he was in the city and when health permitted. He was courteous and helpful to the minister, a gentleman of the old school, reverent, open-minded, transparently sincere, and responsive to every call of human need.

I have said to Mrs. Orton what I would like to say also to you all, that if the central attitudes of Jesus of Nazareth, apart from all theological ideas about him, are the central factors in religion, General Orton was as good a Christian as any and a better Christian than most of us.

A re-birth of intellectual honesty, a fearless, scientific search for facts, a willingness to speak the truth as God gives a man to see the truth, an unselfish devotion to his family and to the public good, a deep, instinctive sympathy with the oppressed, the neglected, and the needy classes; these are the marks of this happy warrior who being dead yet speaketh.

There was a side to him that the world could not see, an eager mind turning for deep spiritual inspirations to poetry, and often expressing himself in his own verse. A deep, emotional life finding satisfaction in the best music and the highest art. Those of us who met him only on boards and committees need to see the scholar poring over his books, and the artist soul reveling in the inspirations of the past. We need to see also the man in his home, the soul of kindly hospitality and devoted to the finest and best and most tender ideals of American family life. If all that is not religion then I am in dire need of some new definition. "A new commandment," said Jesus once, "I give unto you, that ye love one another even as I have loved you. Greater love hath no man than this, that a man lay down his life for his friends. Whoso would be greatest among you, let him be your servant, for even so the Son of Man came not to be ministered unto but to minister."

The Lord bless you and keep you,
The Lord make His face to shine upon you and be gracious unto you,
The Lord lift up His countenance upon you and give you peace,
Now and forevermore—

Amen.

MEMORIAL SERVICES OF THE AMERICAN CERAMIC SOCIETY FOR EDWARD ORTON, JR.

Willard Hotel, Washington, D. C.

February 10, 1932

PRESIDENT POSTE: It is a sad responsibility as the first of my office, that we now take part in a Memorial Service in memory of our leader who left us today.

It is given to but few men to serve and to lead as did General Orton. I doubt if many men have had the opportunity to inspire others to be and to do as he did. It is fitting that we alter our program tonight in his honor.

The arrangements which have been made involve words of tribute from men who have been closely associated with the General, and it is appropriate that we first call upon A. V. Bleininger, since he was the first instructor associated with Professor Orton (as he was known in those days), when he was an instructor in the Department of Ceramics at Ohio State University in 1898 and 1899, under the General's leadership.

ALBERT VICTOR BLEININGER: Mr. President, Ladies, and Gentlemen: It seems exceedingly futile to attempt a eulogy of Edward Orton. It was my privilege to be associated with him as a student and as assistant for practically eleven years. During that time, of course, it was possible to catch a glimpse here and there of his individuality. His character was one which had many sides.

Professor Orton was passionately devoted to science. He was most humble in its service. He was by nature a lover of mankind. He was also a pronounced lover of nature in all of its aspects. Geology was ever his dearest study. He was an American gentleman of the highest type, a passionate lover of truth and justice, a broad thinker, an altruist, a striver after the beautiful. He was also a great patriot, ever thinking of his country and its defense. And, if I may say so, he was also a gentle humorist. He had the art of seeing the humorous in life. He could observe many things of interest wherever he happened to be.

This SOCIETY, of course, was the darling of his heart, his greatest monument. To it he gave probably the greatest effort of his life. We all have seen and have felt his presence, and he still lives in us.

Several years ago it was my privilege to return with him from Indianapolis from attending the funeral of a mutual friend. During that trip we discussed death and the fate of man. He brought out the thought that one should look at life with the inner spirit of science. He had no fear for the future of mankind.

His departure is not only a great loss to his family, but also to his associates, to this SOCIETY, his University, the city of Columbus, the state of Ohio, the United States, nay, the whole world. We must bow to the inevitable and we can honor him only by carrying on his work, not through words, but by deeds.

PRESIDENT POSTE: Probably no man, with the exception of General Orton, has given as much time to the welfare of this organization as has the one whom I shall call next. He is a man who, perhaps, has been closer to General Orton in many ways than any of the rest of us, and in a

large measure he has worn the mantle which goes to him who is most actively connected with our organization as its Secretary.

Mr. Purdy was at Ohio State University for two periods, from 1902 to 1904, and from 1906 to 1912. You are familiar with some of the later phases of his associations with General Orton.

SECRETARY PURDY: Mr. President, Mr. Chairman, Ladies, and Gentlemen: We have had to expect this death, but expecting it as we have been, nevertheless it has fallen suddenly.

General Orton was stricken last fall, and he had been lying critically ill all of this time.

Student

In school, General Orton was a popular student. I know his classmates. They always speak of the romping Ed. He was the man who organized the University band, played the first cornet in the band, and sponsored student organizations. Graduating from Ohio State University he went into metallurgy.

Metallurgist

It has been my fortune to be associated socially with two of the men who worked in the steel laboratories with Edward Orton. They are now high in the council and management of the steel companies. They have told me that no man ever worked in the steel industry who had a keener analytical mind in the devising of alloys, and had he remained in the steel industry, he would have risen high in managerial positions and in the end would have become very wealthy. They mourn his loss to the steel industry.

He then went into geological work, which, as Mr. Bleininger has said, was next to his heart. This led him to study of clays and almost immediately it brought to him the realization that ceramics required a technical collegiate course. It was at this time that he founded the first collegiate course of ceramic engineering in the world.

Educator

To those of us who have given considerable time to teaching, his course as laid down prior to his teaching one single year is a marvel of broadness and exactness; it is a model curriculum. Naturally, with passing time, requirements have changed and the curriculum has been changed. But the foundation laid by Edward Orton, Jr., in 1894 is still the foundation on which ceramic engineering education in this country is founded and is operated.

Administrator

While he was Professor of Ceramic Engineering, head of the department, he took upon himself the deanship of the College of Engineering, carrying

that work successfully forward, securing from the Legislature a bill for the establishment of the Engineering Experiment Station, and establishing in the Engineering College several things that were in advance of the times. He was always an organizer.

Geologist

In geology, as State Geologist of Ohio he served for a great many years. He reëstablished economic geology in Ohio which has gone on steadily because of the sound foundation and organization that he gave it at that time.

In addition to economic geology, Edward Orton, Jr., was especially interested in vulcanology, meteorology, seismology, and in glaciation. He had a collection of meteorites; he had motion pictures of active volcanoes; his studies on glaciation were extensive. He headed a survey in Estes Park where a mountain has since been named Orton in recognition of his work. He was a Fellow in the Geological Society.

Founder

At a meeting in Pittsburgh in 1898, some of the younger men complained that when they read their papers the audience left. Moreover, when a larger group of the men assembled at that meeting stated that they could not understand what the young chaps were saying, Edward Orton, Jr., was the gathering point for the organization of what has since become the AMERICAN CERAMIC SOCIETY. He worked out the Constitution and the structure on which the SOCIETY has been built. For nineteen years, he was its Secretary, relinquishing that post only to go to war.

We have been fortunate since that time to have his interest and his coöperation. Last year he served as President of this SOCIETY.

Investigator

Characteristics of Edward Orton's unselfish interest and willingness to give of himself to others could be shown by recitation of many and varied stories. For instance, if he had a commission to survey a property for a friend, he would take transite and chain and do the work himself. He could close a survey. He was talented in many ways. He was a man for detail.

When the street railway companies in Columbus (where there were a holding company and three operating companies) combined, he had invested interests which brought him into the council. Almost immediately he was assigned the task of evaluating these properties. Knowing little about accounting and being scarcely able to read the books, he succeeded

in bringing out a report on the valuation of these properties that was accepted by the business men and the bankers of Columbus.

Civic Leader

As president of the Columbus Chamber of Commerce, he succeeded in having grade crossings and boulevards started which for many years others had futilely attempted. As treasurer of a welfare guild he established a recreation camp. To this he contributed liberally of his time, talent, and money. As chairman of the Columbus Community Fund in 1930 he was the first to put that fund "over the top" in Columbus.

Organizer

The man was painstaking, thorough, always gaining his objective. Nothing ever seemed to be beyond his capacity. He was never afraid to attempt a big task. The Distinguished Service Medal was awarded at the close of the World War, because he obtained centralization in his office of this country's transport service and because, recognizing the need of a standard motor, he gathered together America's best motor engineers and insisted that they unselfishly pool their abilities and resources. He was the compelling force that resulted in the famous Liberty motor.

Manufacturer

He established what he considered a monument to himself and a great aid to ceramics in this country when he began the manufacture of pyrometric cones. Cones were then made in Germany and sold in this country for four cents a piece and later for three cents. He decided that he could make and sell these cones for two cents apiece. I know, being associated with him on that task, that he lost money for the first four or five years on those cones.

He finally persuaded the ceramic industry to use them and their manufacture has since been developed into a thriving business. He was not content just to make cones. He made studies of cone mixtures and of temperature measurements, and I think you will recall the papers that he has presented on these subjects.

Democratic

Humanly, he was as Albert Bleininger has said. I have seen him romp with his big Saint Bernard and play with children while he was firing the kiln. He was never above wearing overalls, mixing clays, and firing the kiln when we were students.

Personal Influence

I want to testify, as Secretary of this SOCIETY for the past ten years, to the fine humanistic support and comradeship that he has given me for these ten years, as a fellow instructor for about that same length of time, and as a student.

Recently, in writing to Mrs. Orton, I stated that I know of no man, except my own father, who so greatly influenced my life. I think that testimony can be given by other men. Thank you for this opportunity.

PRESIDENT POSTE: We have been much interested in hearing these intimate references to the life of General Orton.

It was not my privilege to be a student under Dr. Orton, but he was present twenty years ago (I think it was in March instead of February) at the first meeting of the AMERICAN CERAMIC SOCIETY that I attended. At that time I became acquainted with Dr. Orton. Again, while I was not among those of the earliest groups whose acquaintance became so intimate through meetings of the SOCIETY, I was a member long enough prior to the formation of Divisions to have enjoyed greatly the contact that we had at that time.

There is just one personal word that I shall give to indicate the esteem in which I have always held Dr. Orton since becoming acquainted with him. One of my hobbies is along the line of hero worship, in the form of reading biographies and procuring pictures of individuals whom I admire. The three pictures that hang in my study at home are in order of acquaintance, first, Dr. J. H. James, my professor of chemistry at Carnegie Institute of Technology, second, Dr. Orton, and then, going back through several years, Louis Pasteur.

President Poste suggested that a motion be made to appoint a Committee on Resolutions to draw up a proper expression of the sentiments of the AMERICAN CERAMIC SOCIETY on the loss of Edward Orton, Jr. This motion was made by Amos Peaslee Potts who was associated with General Orton as an assistant instructor. The motion was seconded and carried.

President Poste then appointed A. S. Watts, F. H. Riddle, and G. H. Brown to draw up the Resolutions.

As official delegates to attend General Orton's funeral in Columbus, Ellis Lovejoy, W. D. Richardson, and S. R. Scholes were appointed.

Before the Memorial Service was adjourned, at the suggestion of the President, the audience stood with bowed heads in honor of General Orton.

Mr. Poste attended the funeral *ex-officio* and Professor C. W. Parmelee of the University of Illinois, Urbana, Ill., Henry C. Kleymeyer of Evansville, Indiana, Albert Bleininger of East Liverpool, Ohio, and Marion W. Blair of Terre Haute, Indiana, were also present.

RESOLUTIONS ADOPTED AT A MEETING OF THE AMERICAN CERAMIC SOCIETY HELD IN MEMORY OF GENERAL EDWARD ORTON, JR.

Whereas, in the death of General Edward Orton, Jr., the AMERICAN CERAMIC SOCIETY has lost its founder, its foremost leader, and its greatest inspiration for unselfish service; and

Whereas, General Orton, by his enthusiasm, ability, and energy, set an example of the highest ideals in organizing and leading this SOCIETY, having been its Secretary and Editor for nineteen years, President, instigator of many of its most fruitful activities, a frequent contributor to our scientific literature, and a constant source of inspiration to its members, particularly the young men, for whom he had an especial sympathy and understanding; therefore be it

Resolved, that we, the officers and members of the AMERICAN CERAMIC SOCIETY, in this Memorial Service express to his family our profound grief and sense of loss at his passing, and our sympathy for them in their sorrow.

Committee FRANK H. RIDDLE
GEORGE H. BROWN
ARTHUR S. WATTS

Washington, D. C.
February 10, 1932

RESOLUTIONS BY BOARD OF TRUSTEES OF THE AMERICAN CERAMIC SOCIETY ON THE PASSING OF EDWARD ORTON, JR.

Edward Orton, Jr., has been called from his labors; he has gone to his heavenly reward; from labor to everlasting rest.

While here, Edward Orton, Jr., developed and used his unusual talents unselfishly for his fellowmen. His records of achievements will last as long as history endures. In ceramics, in geology, in education, in national defense, and in civic and humanitarian affairs, he made a record that will last.

He was an originator, organizer, promoter, and successful leader.

As founder of the world's first collegiate course in ceramic engineering; as organizer, and for nineteen years the Secretary of the AMERICAN CERAMIC SOCIETY, and in 1932 its President, Edward Orton, Jr., won the appellation of "Dean of Ceramics in America."

Therefore, we, the Trustees of the AMERICAN CERAMIC SOCIETY, wish to record our respect, love, and appreciation for all that he has builded for us to enjoy, for his inspired leadership, and for his fellowship.

We share with his family a thanksgiving to the Almighty for his many talents, his abilities, and his generosities.

We shall miss his intimate and loving comradeship; we shall miss his compelling and crystallizing influence.

Mindful of all that Edward Orton, Jr., has been, and for all time will be, we, the Trustees of the AMERICAN CERAMIC SOCIETY, wish to make record of our obligations, and to make known our profound regret that he is no longer spared to share in the many activities which evidently he so greatly enjoyed.

We share with his family a loss inexpressible and a joyful remembrance unusual of our inspiring leader and friend, Edward Orton, Jr.

EMERSON P. POSTE, *President*
E. V. ESKESEN, *Past-President*
GEORGE A. BOLE, *Past-President*

RESOLUTIONS BY FELLOWS OF THE AMERICAN CERAMIC SOCIETY ON THE DEATH OF EDWARD ORTON, JR.

Resolved, that the Fellows of the AMERICAN CERAMIC SOCIETY express their profound regret and keen sense of loss in the death of General Edward Orton, Jr.

Many of the Fellows have had the good fortune to receive instruction and inspiration in the classes of the first ceramic course in America which he founded at Ohio State University in 1894. His students have always affectionately remembered his kind, sympathetic, and ever-helpful attitude with respect to their problems and ambitions. He was the master teacher who implanted his ideals as well as a sound academic training in the lives of many young men who have since succeeded with the preparation he gave them, and of whom many are now Fellows of this SOCIETY. To these old students the memory of Professor Orton will always be a happy and most grateful one.

The Charter Members of the AMERICAN CERAMIC SOCIETY, now Fellows, will recall with appreciation the work of Edward Orton in organizing the SOCIETY in 1898, and conducting its affairs until its permanence and success were assured. Under the ceramic industrial conditions of the time, only a man of unusual patience, friendliness, tact, and ability could have so well succeeded in creating an organization in which mutual helpfulness was to be the principal consideration. Secretary Orton was the beloved executive whose personality insured the SOCIETY of a solid foundation for the future.

After an interval of some years during which Edward Orton served his country, his city, and his Alma Mater in various capacities with distinction and success, he returned to the work of the AMERICAN CERAMIC SOCIETY

and in 1930 undertook the formation of the group to be known as Fellows. He was keenly interested in the possibility of such a group in the AMERICAN CERAMIC SOCIETY, and gave unsparingly of his time and energy in working out the plans for its formation. As in other endeavors, he succeeded in laying the foundation upon which others can safely build with assurance of its honesty of purpose, unselfish principles, and high ideals.

The Fellows of the AMERICAN CERAMIC SOCIETY are proud indeed to have had Edward Orton, Jr., their founder.

Be It Furthermore Resolved, that copies of these Resolutions be spread upon the minutes of the Fellows of the AMERICAN CERAMIC SOCIETY and transmitted to the family of our beloved associate.

Committee L. E. BARRINGER
ROSS C. PURDY
EMERSON P. POSTE

EDWARD ORTON, JR., ESTABLISHES A CERAMIC RESEARCH FOUNDATION

To preserve the enterprise he founded in the interests of the industry to which he gave the best years of his life as a scientist, engineer, teacher, and manufacturer, the Edward Orton, Jr., Ceramic Foundation is created by the will of General Edward Orton, Jr., who died February 10. The will was probated Saturday, February 27, 1932.

The Foundation is established for two purposes: to continue the manufacture and sale of the highest grade pyrometric cones used in industry, and to use the profits therefrom to advance "the ceramic arts and industries in the United States."

Under the will, the estate is divided into two parcels. The first, comprising General Orton's cone manufacturing business, known as the Standard Pyrometric Cone Co., 1445 Summit St., will be used to establish the Foundation. The second will consist of the residue of the estate and is left to the widow.

The proceeds of a life insurance policy for $10,000 are left to Ohio State University for the maintenance there of the Edward Orton Memorial Library of Geology which General Orton had established in memory of his father, the first President of the University, and to which he had annually given $500 for new books.

The partial proceeds of a life insurance policy are used to make small bequests to members of the family.

The will sets up a self-perpetuating Board of Trustees to administer the Foundation. It will consist of the following: the President of Ohio State University, a representative of the U. S. Bureau of Standards, the head of

the Engineering Experiment Station of the Ohio State University, the head of the Department of Ceramic Engineering of the Ohio State University, the Secretary of the AMERICAN CERAMIC SOCIETY and one other representative of the SOCIETY to be chosen for a 3-year term, and an attorney. The trustees are to receive $1 a year and their expenses.

The trustees are to organize within 90 days and take over the cone business and provide for its operation. The will designates Colonel Simeon Nash, General Orton's attorney, as the attorney member of the board.

Orton Memorial Laboratory, 1445 Summit St., Columbus, Ohio. The frieze on two sides and the front of the Memorial building will contain medallions similar to that of Alexander Brongniart recently presented by the French government. These medallions, in most cases original works of art, will represent ancient as well as modern cultures in the ceramic arts.

The will reveals how close the American ceramic industry was to General Orton's heart. It gives the following explanation for the establishment of the trust:

"There are two purposes for which this trust is created. The first and principal purpose is to provide a stable and dependable organization for continuing the manufacture and sale of Standard Pyrometric Cones of the highest quality and most exact accuracy that is commercially feasible, at a reasonable price. The second and subsidiary purpose of this trust is to provide a research organization for the prosecution of studies and researches

for overcoming technical and manufacturing difficulties, and for thus advancing the ceramic arts and industries in the United States.

"Prior to 1896, there was no convenient or generally accepted mode of regulating the firing process or heat treatment of clayware in the ceramic industries of the United States, and virtually no mode of comparing kiln-firing practice, as between different factories and different industries. I entered the manufacture and sale of pyrometric cones with the purpose of performing a definite and needed service to the ceramic industries:

Plaque for France depicting Alexander Brongniart made by Jean Gauvenet, Sèvres, France.

"(1) By enabling them to better control the firing of their products, which is the weakest point of the manufacturing process; (2) by facilitating the freer exchange of exact information concerning the firing process between ceramic manufacturers, and (3) thus inducing a better and more coöperative relationship among them, and thus making greater scientific and industrial progress probable.

"In this enterprise, while manufacturing profit is essential to permit its continuance, it has, from the first, been my purpose to make financial profit incidental to the principal idea of furnishing to ceramic manufacturers a mode of controlling or regulating the firing process of their ware with the

highest attainable degree of dependability at the lowest reasonable cost. Having been successful in obtaining the confidence of manufacturers of ceramic products in Standard Pyrometric Cones, it is my desire to assure myself that the manufacturing establishment which I have built up shall

Bust of Josiah Wedgwood in niche in entry way of Orton Memorial Laboratory. A similar bust of Hermann Seger is being made.

continue to fulfil this same useful purpose, upon the same high plane, and with the same ideals of public service, after my death."

If for any reason it becomes impossible to continue to operate the business successfully, the trustees are authorized, with approval of the probate court, to close the business and to turn the assets over to the Ohio State University as part of the irreducible debt of the state of Ohio, the income therefrom to

be used for ceramic research either through the university's Department of Ceramic Engineering or its Engineering Experiment Station.

In carrying out his wishes, General Orton recommended that the trustees adhere to the following policies:

"That the salaries and wages paid to all employes shall be liberal, and somewhat above the general wage-plane of persons of similar education and skill, working in other lines, to the end that the men and women employed shall have no just grievance upon either working conditions or wages.

"That the principle of a bonus or profit-sharing, which I have employed informally for many years in this business, without making it a contractual element in fixing the wage or salary of any employe, be continued, to the end that all employes may justly be expected to feel a community of interest in making the business efficient, in the avoiding of errors or inaccuracies, and in keeping high the good name of Standard Pyrometric Cones.

"That, if possible, the selling price of the product shall be kept well below that of foreign cones imported to this country, and if feasible, as low, or lower, than the prices at which foreign cones are sold in the countries of their origin, to the end that American ceramic manufacturing shall have an advantage in competing for foreign trade, so far as this element of cost of production of their ware is concerned.

"That, after giving due consideration to these three policies, the price at which cones shall be sold shall be set to produce a gross income, of which approximately 80 per cent will be required to meet the manufacturing costs, including sales, overhead, and the maintenance of proper capital reserves for extensions, depressions, or disasters, and including the cost of experimental work undertaken specifically for the needs of the cone manufacturing process itself. The remainder of the gross receipts of the cone manufacturing business being approximately 20 per cent of the same shall be expended upon research. It is the testator's belief that the great majority of consumers of cones will willingly approve of the principle of charging a profit of 20 per cent, the same to be spent in research for their own ultimate benefit."

The research division of the Foundation may be set up as a part of the cone manufacturing establishment or separately at the discretion of the trustees. In the latter case, the will suggests, it "would be used principally to stimulate and assist research, and to coördinate, supervise, and supplement researches undertaken in the Ceramic Department and Engineering Experiment Station of the Ohio State University, or by other laboratories or groups of laboratories..." In such cases, also, the research director would be authorized to "furnish personnel or loan equipment to laboratories cooperating with him." The will further provides that results of research promoted by the Foundation shall be published "to the end that said results

shall be given freely to the public and made available for the use of the ceramic industries."

The Board of Trustees is directed not to "sell or permit its agents and employes to sell, or to make any charge, direct or indirect, for any information furnished through or by said research department, to the end that all surplus over and above the cost of production made upon the sale of Standard Pyrometric Cones shall be returned to the ceramic industries in the form of technical knowledge."

The will further provides that because of the creation of the trust the estate is "severely depleted" and there has been taken from it "its chief income producing element," that for five years there shall be paid to Mrs. Orton specified sums from current earnings of the cone business.

Mrs. Orton and Colonel Nash were named co-executors of the will, which requested that they be not required to furnish bond. The will, dated October 6, 1928, consisted of 13 typewritten, legal-size pages. No estimate was made of the value of the estate.

ACTIVITIES OF THE SOCIETY

OFFICERS OF THE AMERICAN CERAMIC SOCIETY, 1932–33

President: Emerson P. Poste, Consulting Chemical Engineer, Box 51, North Chattanooga Station, Tenn.
Vice-President: W. Keith McAfee, President, Universal Sanitary Mfg. Co., New Castle, Pa.
Treasurer: H. B. Henderson, Standard Pyrometric Cone Co., Columbus, Ohio.
Past-Presidents: E. V. Eskesen, President, Federal Seaboard Terra Cotta Corp., 10 East 40th St., New York, N. Y. Alexander Silverman, Univ. of Pittsburgh, Pittsburgh, Pa. (Appointed to fill the uncompleted term of Edward Orton, Jr.)

Division Trustees

Art: Charles L. Sebring, Sebring Pottery Company, Sebring, Ohio.
Enamel: W. C. Lindemann, A. J. Lindemann & Hoverson Co., Milwaukee, Wis.
Glass: Francis C. Flint, Hazel-Atlas Glass Co., Washington, Pa.
Materials and Equipment: Victor V. Kelsey, Consolidated Feldspar Corp., Trenton, N. J.
Refractories: J. M. McKinley, North American Refractories Co., Cleveland, Ohio.
Structural Clay Products: Henry C. Kleymeyer, Standard Brick & Tile Corp., Evansville, Ind.
Terra Cotta: Duane F. Albery, Northwestern Terra Cotta Co., Chicago, Illinois.
White Wares: Daniel Parry Forst, Robertson Art Tile Co., Trenton, N. J.

OFFICERS OF INDUSTRIAL DIVISIONS, 1932–33

Art
Chairman: Walter P. Suter, American Encaustic Tiling Co., 16 E. 41st St., New York, N. Y.
Secretary: Kenneth E. Smith, Newcomb College, New Orleans, La.

Enamel
Chairman: William V. Knowles, Titanium Alloy Mfg. Co., Cleveland, Ohio.
Secretary: W. N. Harrison, Bureau of Standards, Washington, D. C.

Glass
Chairman: E. Ward Tillotson, Mellon Institute, Pittsburgh, Pa.
Secretary: Jack Waggoner, Mellon Institute, Pittsburgh, Pa.

Materials and Equipment
Chairman: Henry F. Kleinfeldt, Abbé Engineering Co., New York, N. Y.
Secretary: V. V. Kelsey, Consolidated Feldspar Corp., Trenton, N. J.

Refractories
Chairman: S. M. Phelps, Mellon Institute, Pittsburgh, Pa.
Secretary: H. E. White, Lava Crucible Corp., Zelienople, Pa.

Structural Clay Products
Chairman: Amos P. Potts, Clay Products, Inc., Brazil, Ind.
Secretary: Marion W. Blair, Terre Haute, Ind.

Terra Cotta
Chairman: R. F. Grady, Jr., Winkle Terra Cotta Co., St. Louis, No.
Secretary: Donald J. Watson, 173 Rector St., Perth Amboy, N. J.

White Wares
Chairman: H. M. Kraner, Westinghouse Electric & Mfg. Co., Derry, Pa.
Secretary: Louis Navias, General Electric Co., Schenectady, N. Y.

AMERICAN CERAMIC SOCIETY AUDIT REPORT, YEAR 1931

Columbus, Ohio
January 21, 1932

Mr. E. V. Eskesen, President
AMERICAN CERAMIC SOCIETY
Columbus, Ohio

Dear Mr. Eskesen:

Following your request, I have audited the accounts of the AMERICAN CERAMIC SOCIETY for the year 1931, and am herein submitting my report. Attached are statements as follows:

I. Statement of assets and liabilities as of December 31, 1931.
II. Statement of income and expenses for the year.
III. Comparative statement of income and expenses for years 1930 and 1931, and division of income and expenses for 1931 as to publication and general.

Cash receipts have been properly recorded and deposited and all payments were made by duly authorized and properly signed voucher check, some of these checks of course being reimbursements to "Revolving Fund" for payments made through that fund. This is a fund of $300.00 and is reimbursed monthly for the amount paid out.

Since early in the year, there have been statements similar to the attached made out at the end of each month. These have been very accurately made out and no doubt have been a great help to yourself and Board in directing the work of the SOCIETY.

I have verified the Cash Balances and Securities and find them correct as listed. The general checking balance was in two banks in approximately equal amounts, and the securities were in possession of the Treasurer in a safety deposit box. In detail the securities were as follows:

	Par	Book
Fourth Liberty Bonds, 4¼%, registered	$4,700.00	$ 9,861.00
First Liberty Bonds, 4¼% Conv., coupon	5,000.00	
U. S. Treasury Bond, 1947/52, 4¼%, coupon	100.00	102.87
U. S. Treasury Bond, 1943/47, 3¾%, coupon	100.00	99.87
Certificate of Deposit in The Buckeye State Building & Loan Co., Columbus, Ohio		1,112.05
Total as per Statement		$11,175.79

It is my opinion that this report correctly shows the financial operations of the AMERICAN CERAMIC SOCIETY for the year 1931, and the true condition at the close of the year.

Respectfully submitted,

A. L. PETERS,
Certified Public Accountant

STATEMENT I

Statement of Assets and Liabilities
(As of December 31, 1931)

Assets

Cash in Bank (general account)		$ 3,067.28	
Cash in Revolving Fund		300.00	
Petty Cash in Office		5.00	$ 3,372.28
Liberty Bonds (par $9700)		9,861.00	
Treasury Certificates (par $200)		202.74	
Certificates of Deposit		1,112.05	11,175.79
Accounts Receivable			1,974.31
Inventories			
Journals		1,266.64	
Transactions		470.00	
Enamel Bibliographies		137.00	1,873.64
Office Equipment (less depreciation)			2,046.31
Deferred Charges			
Advance Expenses on 1932 Meeting			88.07
TOTAL ASSETS			20,530.40

Liabilities

Accounts Payable		6,484.79	
Deferred Income			
Prepaid Dues			
Personal	$ 3,283.85		
Corporation	1,555.00		
Fellows	150.00		
Divisions	489.75		
	5,478.60		
Prepaid Journals (subscriptions)	1,609.13		
Prepaid Advertising	92.48		
Prepaid Curtis Survey	37.00		
Total Deferred Income		7,217.21	
Total Liabilities (inc. deferred income)			13,702.00
Surplus (assets over liabilities)			6,828.40
TOTAL LIABILITIES AND SURPLUS			20,530.40

STATEMENT II

Income and Expense Statement
(Year 1931)

Income			
Dues Earned: Corporation		$ 5,650.28	
Personal		17,973.84	
Fellow (net)		457.09	
A. R. I.		1,526.84	
Divisions (net)		1,292.38	$26,900.43
Journal Sales and Subscriptions			
1931		4,382.04	
1918–1930 Sales	$ 574.37		
Less Decrease in Inventories	287.45	286.92	4,668.96
Advertising		10,856.37	
Miscellaneous Sales of Publications		18.49	
Contributions		2,035.00	
Interest		565.44	
Annual Meeting (income over cost)		666.90	14,142.20
TOTAL INCOME			45,711.59
Expenses			
Cost of Printing *Journal* (less Inventory)		19,658.53	
Abstracts		1,926.90	
Reprints (net)		765.75	
Editor's Office Expense		1,270.92	
		23,622.10	
Salaries	13,905.00		
Secretary's Office Expense	1,727.64		
Office Rent	1,080.00		
Postage	1,352.45		
Traveling	506.87		
Committee Expense	10.32		
Depreciation of Office Equipment	227.36		
Bad Accounts Written Off	194.80	19,004.44	
Inventories Written Down (net):			
Enamel Bibliographies	112.79		
Refractory Bibliographies	249.80		
Transactions	90.00	452.59	
Century of Progress		554.43	
Total Expenses			43,633.56
INCOME OVER EXPENSES			2,078.03
Surplus Account			
Balance January 1, 1931			4,750.37
Income over Expenses			2,078.03
Balance December 31, 1931			6,828.40

STATEMENT III

Comparative Income and Expense Statement (Years 1930–1931)
Division of Income and Expenses for 1931 as to Publication and General

			1931	
Income	**1930**	**1931**	**Publication**	**General**
Dues, Corporation	$ 5,951.35	$ 5,650.28	$ 1,470.00	$ 4,180.28
Dues, Personal	16,153.19	17,973.84	9,132.00	8,841.84
Dues, Fellow		457.09		457.09
A. R. I.	954.50	1,526.84	1,038.00	488.84
Divisions	1,134.70	1,292.38		1,292.38
	24,193.74	26,900.43	11,640.00	15,260.43
Journals (current year)	4,030.39	4,382.04	4,382.04	
Journals (previous years, net)	313.93	286.92	286.92	
	4,344.32	4,668.96	4,668.96	
Advertising (net)	15,077.16	10,856.37	10,856.37	
Miscellaneous	78.25	18.49	18.49	
Contributions		2,035.00		2,035.00
Annual Meeting (net)	Loss (798.44)	666.90		666.90
Interest	535.28	565.44		565.44
	14,892.25	14,142.20	10,874.86	3,267.34
TOTAL INCOME	43,430.31	45,711.59	27,183.82	18,527.77
Expenses				
Cost of Publication	22,676.95	19,658.53	19,658.53	
Abstracts	2,569.69	1,926.90	1,926.90	
Reprints (net)	657.43	765.75	765.75	
Editor's Office Expense	1,837.30	1,270.92	1,270.92	
	27,741.37	23,622.10	23,622.10	
Salaries	14,759.75	13,905.00	7,912.00	5,993.00
Secretary's Office Expenses	2,366.21	1,727.64		1,727.64
Postage	1,379.26	1,352.45	550.00	802.45
Office Rent	1,080.00	1,080.00	540.00	540.00
Traveling (except Annual Meeting)	480.64	506.87		506.87
Committee	15.80	10.32		10.32
Miscellaneous	158.25			
Century of Progress		554.43		554.43
Depreciation	246.13	227.36	100.00	127.36
Bad Accounts	187.21	194.80	194.80	
	20,673.25	19,558.87	9,296.80	10,262.07
Inventories Written Down				
Enamel Bibliographies		112.79	112.79	
Refractory Bibliographies		249.80	249.80	
Transactions		90.00	90.00	
		452.59	452.59	
TOTAL EXPENSES	48,414.62	43,633.56	33,371.49	10,262.07
Gain or (loss)	(4,984.31)	2,078.03	(6,187.67)	8,265.70

RECOMMENDED CONSTITUTIONAL AMENDMENTS

The following changes in the Constitution have been approved by the Committee on Rules for submission to the Membership for vote in accordance with Article XIII.

Executive Committee

The following shall be inserted after paragraph (1) of Article IV:

(2) The Board of Trustees will provide for an Executive Committee to facilitate conduct of the SOCIETY's business. This Executive Committee will consist of five members of the Board of Trustees, namely, the President, Treasurer, and three members elected by the Board of Trustees at each Annual Meeting.

The President shall act as chairman of the Executive Committee and will call the meetings which are to be held at least quarterly.

The Executive Committee shall have full power to act for the Board of Trustees during the interim of meetings of the Board.

The Executive Committee will send copies of minutes of its meetings to each member of the Board of Trustees.

Present paragraph (2) of Article IV is to be numbered (3) and all succeeding paragraphs renumbered accordingly.

Committee on Management

The following paragraphs shall be added to Article VI:

(15) The Committee on Management will consist of eight members, one from each of the Divisions of the SOCIETY. These divisional representatives will be appointed by the Chairman of the Divisions and the Chairman of the Committee on Management itself will be appointed by the Board of Trustees.

Its duties shall consist of arranging for papers and discussions relating to management of industrial ceramic organizations. Arrangements with respect to such papers and discussions at the time of the Annual Meeting of the SOCIETY will be made in coöperation with the General Secretary.

The following shall be added to the tabulation in paragraph (1) of Article VI:

(12) Committee on Management.

L. E. BARRINGER, *Chairman*,
Committee on Rules

LOCAL SECTION NEWS

Pacific Northwest Section

A meeting of the Pacific Northwest Section of the AMERICAN CERAMIC SOCIETY was held in the Mines Building, University of Washington, Seattle, Wash., February 27, 1932. The program of papers and discussions for the afternoon and evening sessions was as follows:

(1) Slag Conditions in Boilers Burning Hogged Fuel
By Kenneth Skinner and Norman Field
(2) European Automatic Coal Feeders for Hoffman Continuous Ring Kilns
By Nicholas Mara (graduate student from Czechoslovakia)
(3) Removing Sand and Mica from Kaolins by Pneumatic Methods
By Jack Cunliffe
(4) Heat Balance of a Continuous Tunnel Brick Drier
By Jim Hammock
(5) Humidity Drying of Terra Cotta
By T. E. Nicholson, Gladding, McBean & Co., Auburn, Wash.

(6) Open-Kiln Firing of Terra Cotta
By Thad O. Smith, Kansas City Terra Cotta Co., Kansas City, Mo.
(7) The Function of Time and Temperature in the Vitrification of Clay
By Fred M. Kettenring, Gladding, McBean & Co., Auburn, Wash.

The discussion subjects were (1) manufacture of glazed, hollow, and building tile, (2) machine-made terra cotta, (3) slab terra cotta, (4) cleaning masonry, (5) impervious mortars for brick, tile, and terra cotta, and (6) reinforced brickwork.

Hewitt Wilson, head of the department of ceramic engineering, University of Washington, is Secretary of this Section.

MEMBERS HONORED WITH FELLOWSHIP IN 1932

The following members of the AMERICAN CERAMIC SOCIETY were elected Fellows of the AMERICAN CERAMIC SOCIETY at the Washington Meeting:

Andrew I. Andrews
Howells Fréchette
Arthur Van Henry
Robert Linton
John D. Martin
Thomas Newkirk McVay
C. Forrest Tefft

NEW MEMBERS RECEIVED IN JANUARY

PERSONAL

Tom Falknor, 387 Middlesex Ave., Metuchen, N. J.; Edgar Plastic Kaolin Co.
Rob Roy McGregor, Mellon Institute, Pittsburgh, Pa.; Research Chemist, Macbeth-Evans Glass Co.
John E. Smith, 85th St. and Wesley Drive, Belleville, Ill.; Chief Engineer and Director of Research, Knapp-Monarch Co.
Edgar Wayne Sparks, Ceramic Engineer, 350 Carolina Ave., Erwin, Tenn.
Thorne L. Wheeler, Arthur D. Little, Inc., 30 Charles River Road, Cambridge, Mass.; Assistant Director of Research.

STUDENT

Bernard S. Cohen, University of Illinois, Urbana, Ill.
Paul R. Jones, Ohio State University, Columbus, Ohio
James Laing Sommerville, Pennsylvania State College, State College, Pa.

Membership Workers' Record

PERSONAL		STUDENT	
C. W. Parmelee	1	A. I. Andrews	1
George Simcoe	1	J. B. Shaw	1
Office	3	Arthur S. Watts	1
Total	5	Total	3
		Grand Total	8

ROSTER CHANGES IN JANUARY

CORPORATION*

Clay Products Company, Inc. of Indiana, George Shoemaker (voter), Brazil, Ind. (Membership transferred from Ar-Ke-Tex Corporation.)
Franklin Pottery, Inc., Roy W. Schweiker (voter), Lansdale, Pa. (Membership transferred from personal membership of Roy W. Schweiker.)

PERSONAL*

Boring, James H., 127 Westwood, Jackson, Tenn. (P. O. Box 146, Elgin, Texas.)
Butler, Matthew W., 667 East 115th St., Cleveland, Ohio. (221 East Sheridan Ave., New Castle, Pa.)
Cavanaugh, Dan J., Rouseville, Pa. (Summerville, Pa.)
Grossman, Harold, 97 Huntington Terrace, Newark, N. J. (22 Farrington St., Caldwell, N. J.)
Lawson, Geo. G., 522 Landfair, Los Angeles, Calif. (1709 Livingston St., Evanston, Ill.)
Malsch, Werner, 534 Hudson St., Hoboken, N. J. (350 5th Ave., New York, N. Y.)
Mayfield, Chester C., 101 S. McKenzie St., Mt. Vernon, Ohio. (Brockway Clay Co., Brockway, Pa.)
Parsons, Joseph R., 724 Buncombe St., Hendersonville, N. C. (165 N. Pine Ave., Chicago, Ill.)
Planje, C. W., Northwestern Terra Cotta Co., 4417 Oleatha Ave., St. Louis, Mo. (2525 Clybourn Ave., Chicago, Ill.)
Richardson, Gordon B., W. S. Dickey Clay Mfg. Co., 116 New Montgomery St., San Francisco, Calif. (Address formerly listed as unknown.)
Sandorff, Alfred J., General Abrasive Co., Niagara Falls, N. Y. (Precision Grinding Wheel Co., Holmesburg, Philadelphia, Pa.)
Shaw, D. T. H., Hôtel Regnard, 4 Rue Regnard, Paris (VI), France. (Massachusetts Institute of Technology, Cambridge, Mass.)
Stuecken, Carl G., c/o A. Kellner, Haus Offenbach, Zimmer 57, Frankfurt a Main, Germany. (Wolverine Porcelain Enameling Co., Detroit, Mich.)
Swain, Stephen M., Box 532, Saltsburg, Pa. (Salina, Pa.)
Tailby, Roland V., Lawrenceville, N. J. (315 N. Pennsylvania Ave., Morrisville, Pa.)
Titsworth, Adelene, The Hull House, Chicago, Ill. (327 1/2 N. Vernon Ave., Los Angeles, Calif.)
Wills, George A., 1723 G St., N. W., Apt. 1, Washington, D. C. (1205 Fourth Ave., Ford City, Pa.)

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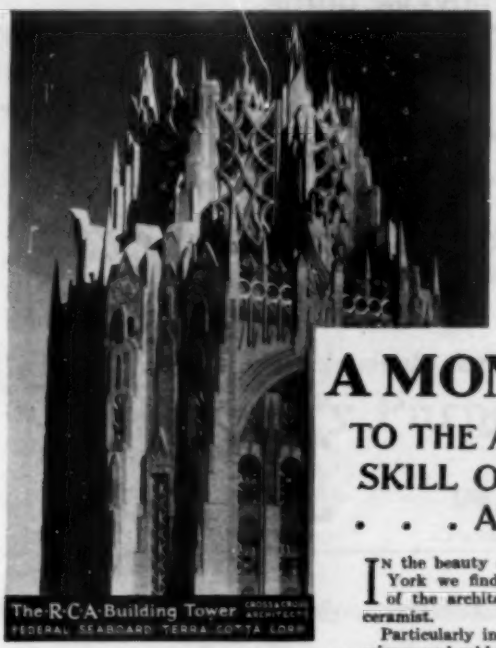
* Addresses within the parentheses ( ) represent the old addresses.

These roster changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.



A MONUMENT

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IN the beauty of the R. C. A. Building in New York we find combined the creative ability of the architect and the skill of the modern ceramist.

Particularly interesting is its tower using aluminum and gold terra cotta to symbolize electric current—producing startling decorative flashes in spandrels, tracery and pinnacles.

This gorgeous example of terra cotta work is by Federal Seaboard Terra Cotta Corporation—a leader in its field.

At its plant at Woodbridge, N. J. kilns twenty-eight feet in diameter are used in the important work of burning the terra cotta products. And in the kiln illustrated you will find (under a covering of sand while kiln is being set) a floor of "Carbofrax"—the Carborundum Brand Silicon Carbide Refractory. This floor was installed over seven years ago yet it is still in excellent condition.

The high thermal conductivity of "Carbofrax"—its extreme refractoriness—have played their part in improving temperature uniformity—in decreasing fuel consumption—in reducing maintenance costs.

"Carbofrax" thus aids in the production of the high quality ware for which Federal Seaboard Terra Cotta Corporation has long been noted.

Here again is an evidence of the service of Carborundum Brand Refractories to industry.

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REG. U. S. PAT. OFF.

The Carborundum Brand Silicon Carbide Refractory

THE CARBORUNDUM COMPANY

Reg. U. S. Pat. Off.

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Christy Firebrick Company, St. Louis, Kansas City, New Orleans, Houston
Pacific Abrasive Supply Co., Los Angeles, San Francisco, Seattle
Williams and Wilson, Ltd., Montreal-Toronto, Canada

(CARBORUNDUM AND CARBOFRAX ARE REGISTERED TRADE MARKS OF THE CARBORUNDUM COMPANY)

BUYERS' GUIDE

A

Alexite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.

Aluminum Oxide (Fused)
The Exolon Co.

Ammonium Bifluoride
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Ammonium Carbonate
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Antimony Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

Automatic Temperature Control
Brown Instrument Co.

B

Ball Mills
Hardinge Co., Inc.
Hommel, O., Co.
McDanel Refractory Porcelain Co.

Ball Mills (Laboratory Type)
Ceramic Color & Chemical Mfg. Co.
Hardinge Co., Inc.
Hommel, O., Co.

Barium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Barytes
Hommel, O., Co.

Batts
Carborundum Co. (*"Carbofrax Aloxite"*)

Bitstone
Potters Supply Co.

Blocks (Refractory)
Carborundum Co.

Borax
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.

Borax Glass
Pacific Coast Borax Co.

Boric Acid (Anhydrous)
Hommel, O., Co.
Pacific Coast Borax Co.

Boric Acid (Crystal, Granular or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.

Brickmaking Machinery
Hardinge Co., Inc.

Bricks (Refractory)
Carborundum Co. (*"Carbofrax Aloxite"*)

Broken Glass
The Bassichis Co.

Burners (Nat. Gas)
Swindell-Dressler Corp.

C

Carbofrax (Refractory Products)
Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

Carbon Dioxide Meters
Brown Instrument Co.

The National Silica Co.

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- Spurs
- Saggers
- Crucibles
- Tile for Decorating Kilns

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- Sagger Clay
- Wad Clay
- Ground Fire Clay
- Bitstone
- Fire Brick
- Imported Paris White
- Domestic Whiting

THE POTTERS SUPPLY COMPANY

EAST LIVERPOOL, OHIO

BUYERS' GUIDE (continued)

Carbonates (Barium, Lead)
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Caustic Soda
Ceramic Color & Chemical Mfg. Co.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.

Cements
Carborundum Co.

Ceramic Chemicals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Metal & Thermit Corp.
National Paint & Manganese Co.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
The Denison Engineering Co.
Harrop Ceramic Service Co.
Philadelphia Drying Machinery Co.
Swindell-Dressler Corp.

Chromium Oxide
Drakenfeld & Co., B. F.
Hommel, O., Co.
National Paint & Manganese Co.
The Roessler & Hasslacher Chemical Co.

Clay (Ball)
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
The Roessler & Hasslacher Chemical Co.
Spinks Clay Co., H. C.

Clay (China)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
Hommel, O., Co.
Paper Makers Importing Co.

Clay (Electrical, Porcelain)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.

Clay (Enamel)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.

Clay (German Vallendar)
Ferro Enamel Corp.
The Roessler & Hasslacher Chemical Co

Clay Miners
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay (Potters)
Spinks Clay Co., H. C.

Clay (Sagger)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay Tests
Harrop Ceramic Service Co.
Swindell-Dressler Corp.

Clay (Wad)
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wall Tile)
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.

Clocks, Gauge Board
Brown Instrument Co.
Ferro Enamel Corp.

CO_2 Meters
Brown Instrument Co.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

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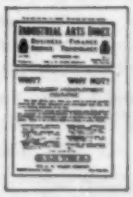

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BUYERS' GUIDE (continued)

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Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel Co., O.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Conditioning Machinery
Philadelphia Drying Machinery Co.

Controllers
Brown Instrument Co.

Conveyers (Clay, Sand, Brick, etc.)
Philadelphia Drying Machinery Co.

Cornwall Stone
Hammill & Gillespie, Inc.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Cornwall Stone (Imported)
The Roessler & Hasslacher Chemical Co.

Crucibles (Filter, Melting, Ignition)
Potters Supply Co.

Cryolite
Hommel, O., Co.

Cullet
The Bassichis Co.

D

Decorating Supplies
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.
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